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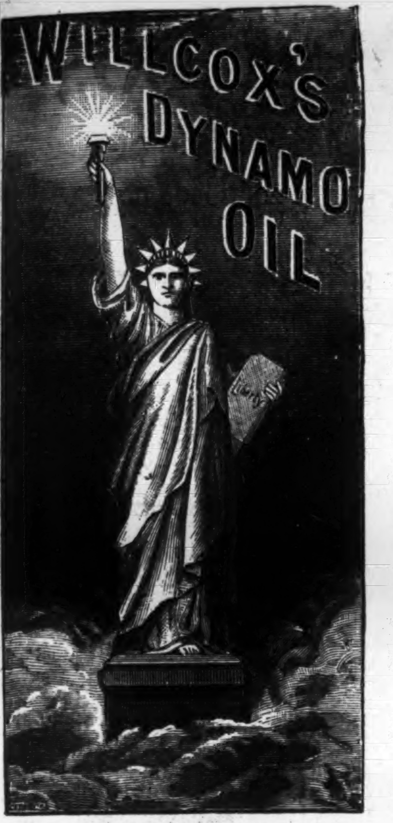

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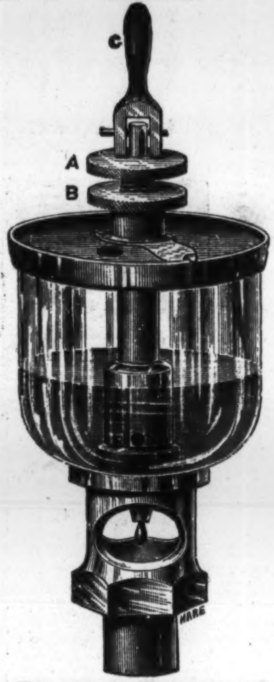

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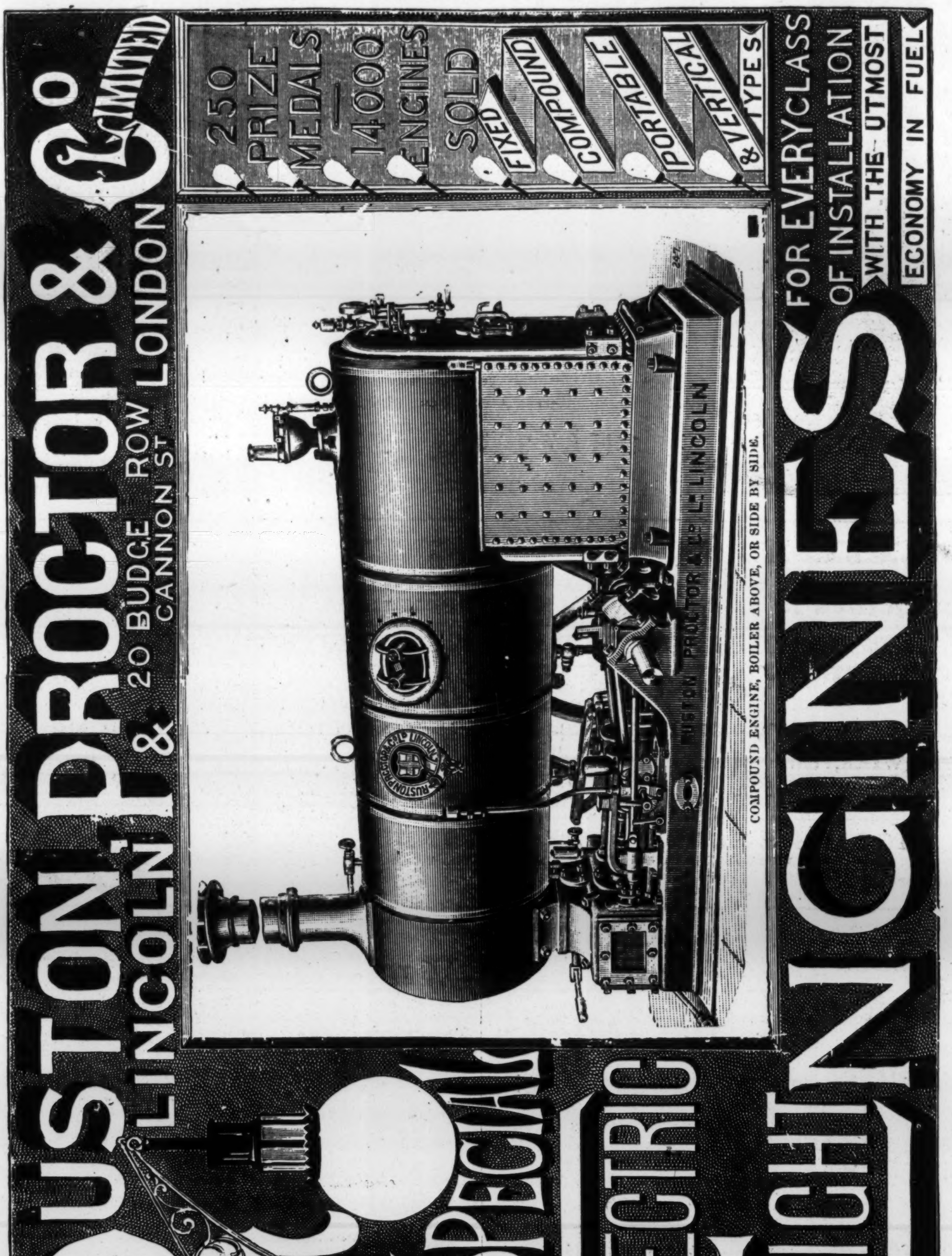
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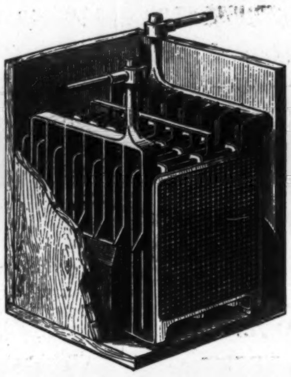

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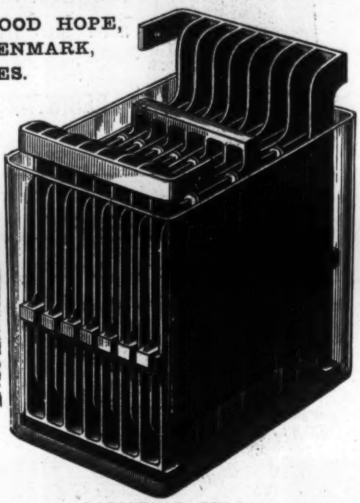

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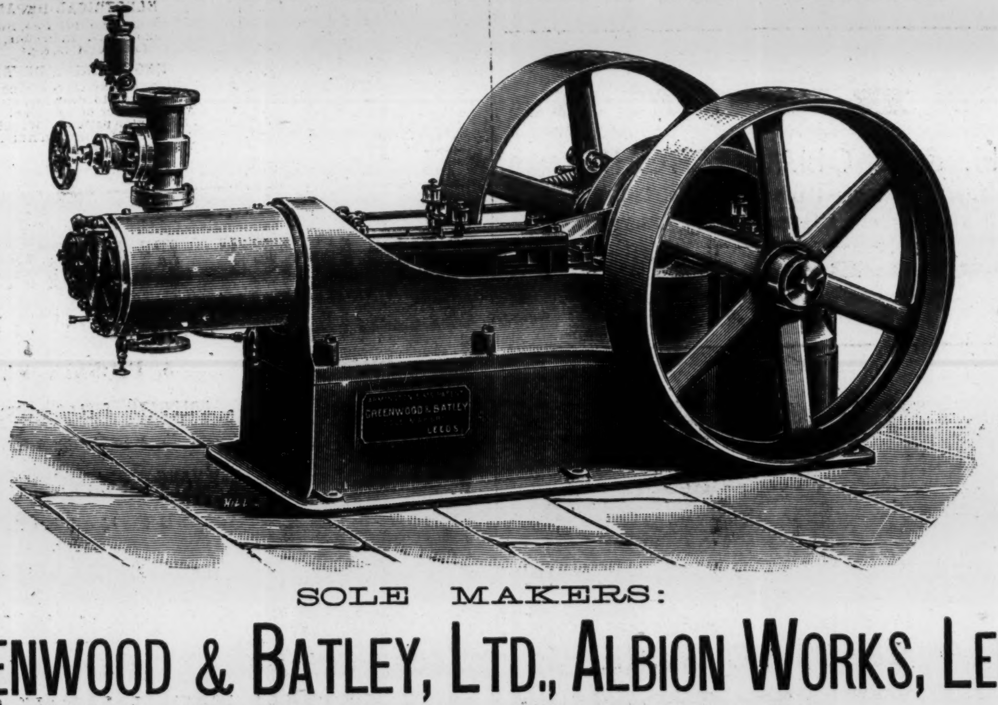

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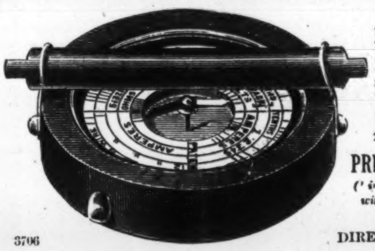

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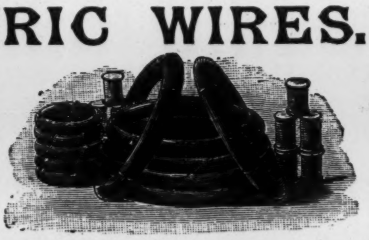

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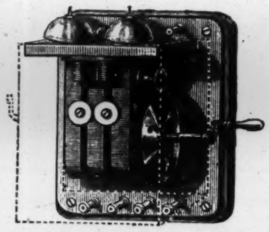

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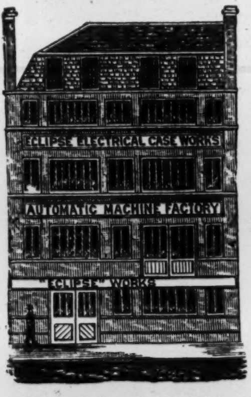

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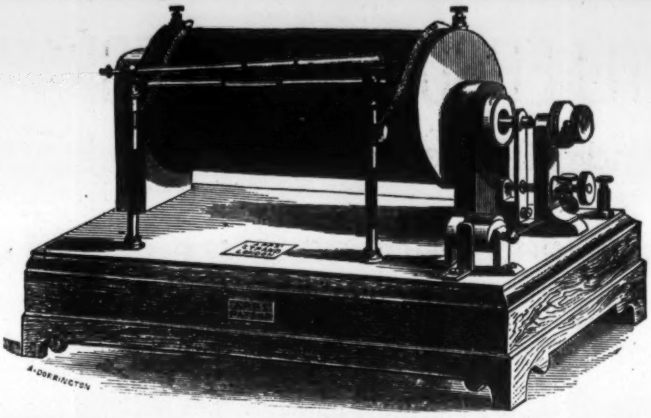

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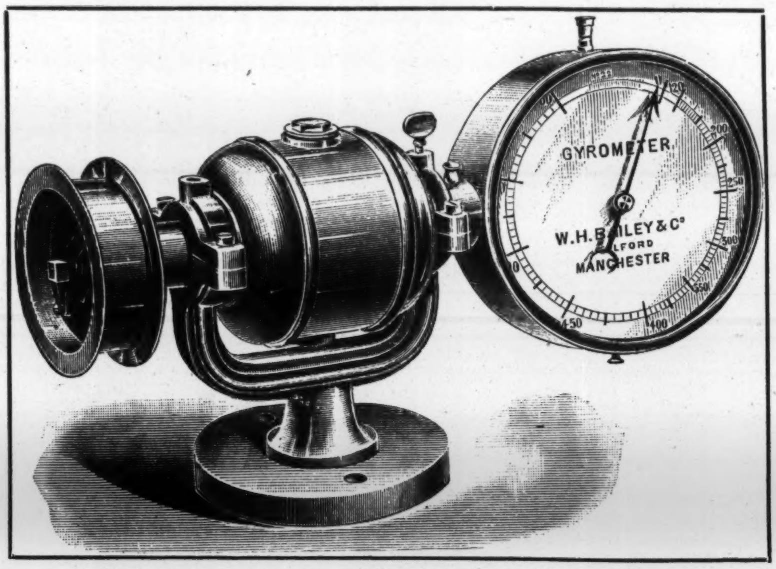

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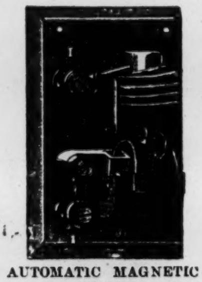

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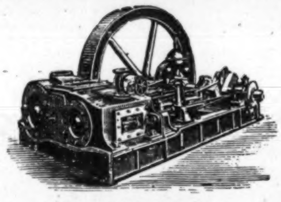

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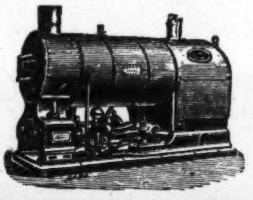

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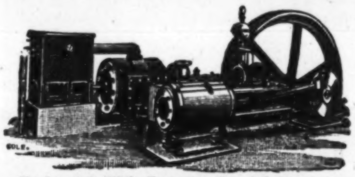

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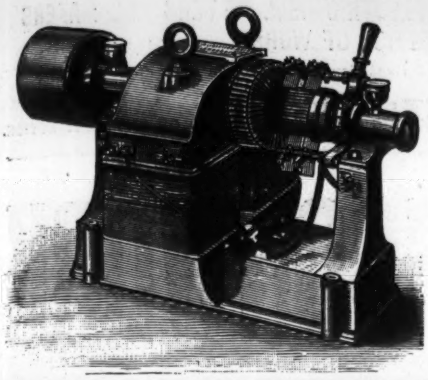

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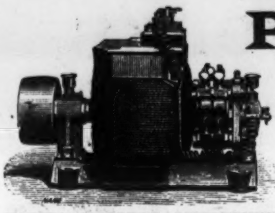

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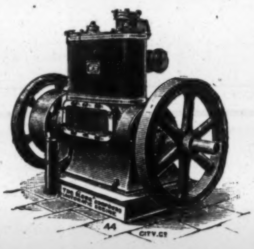

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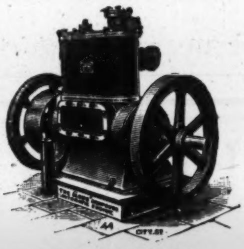

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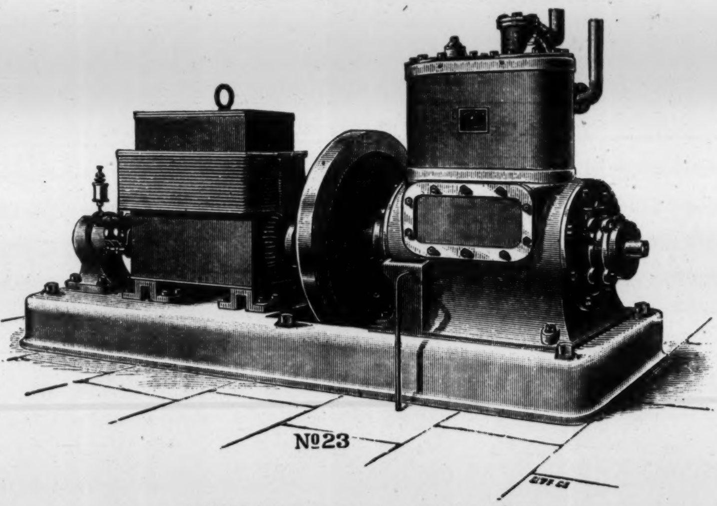

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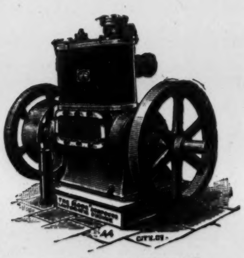

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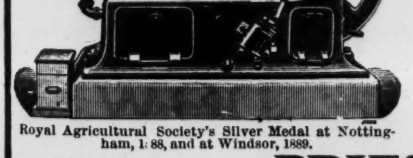

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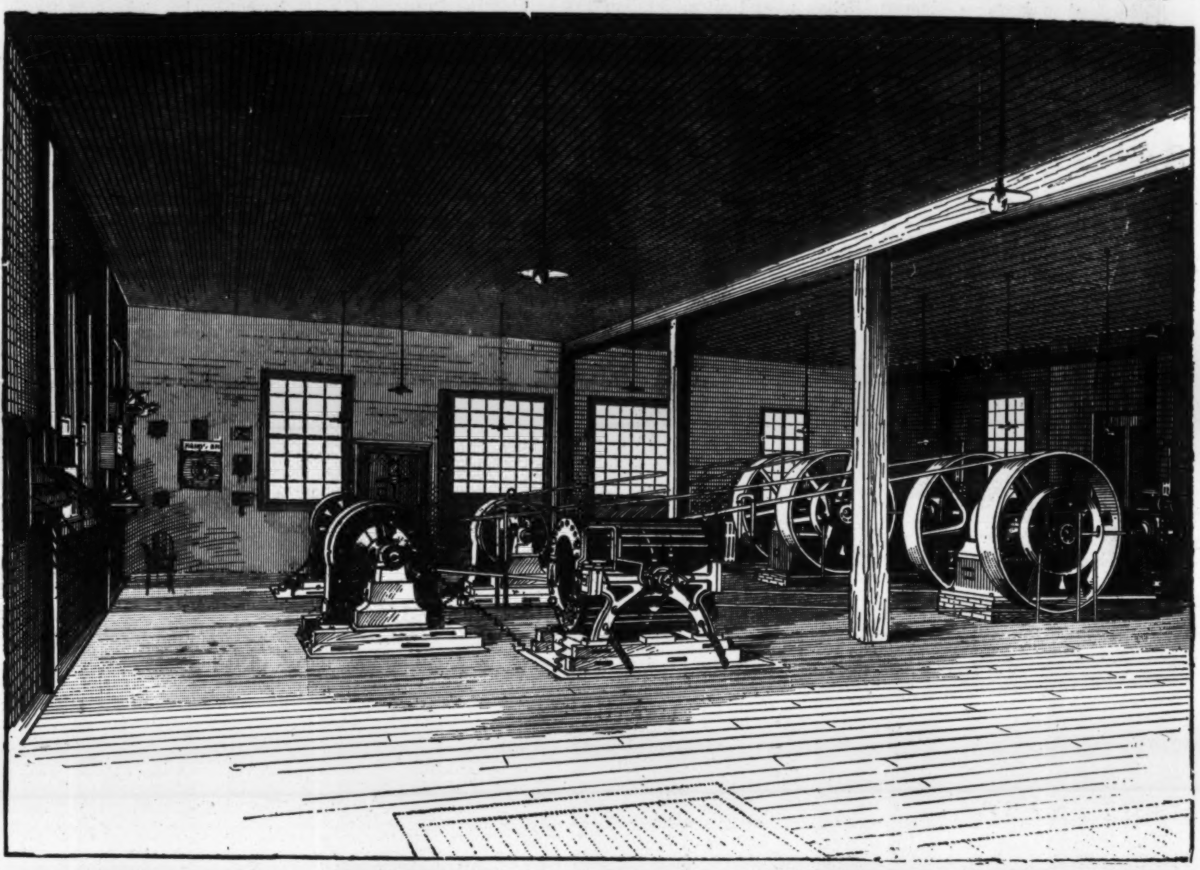

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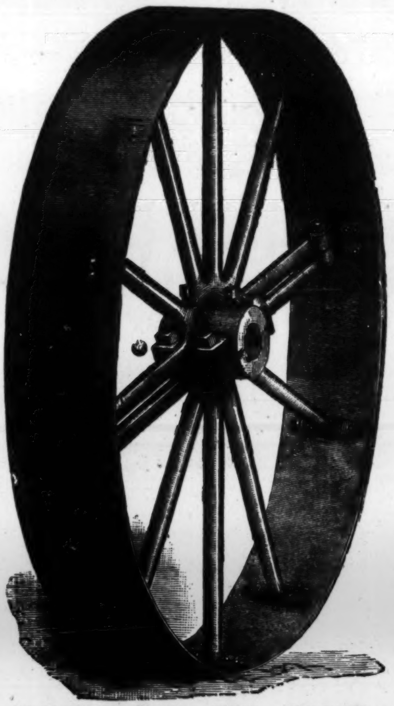

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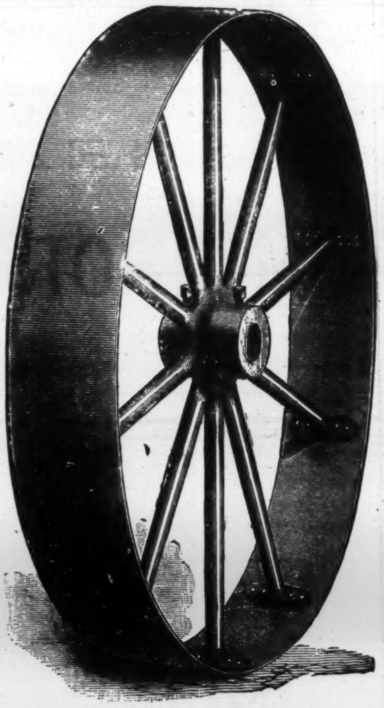

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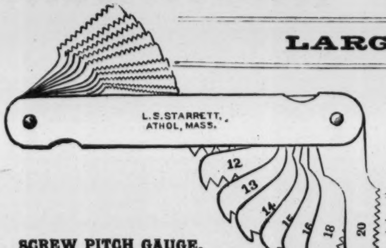

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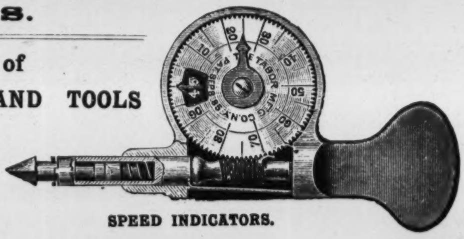

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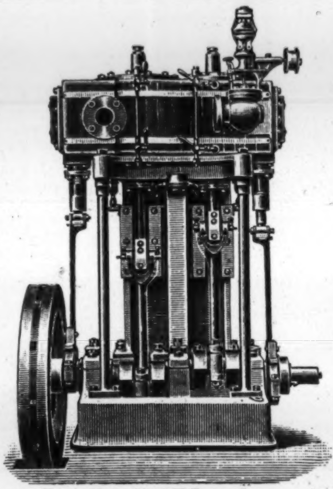

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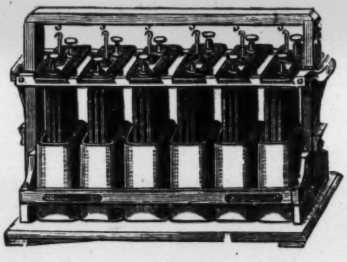

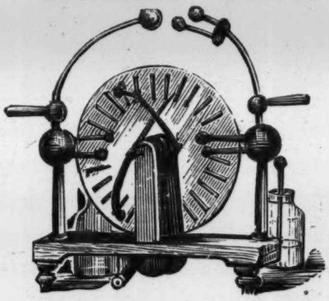

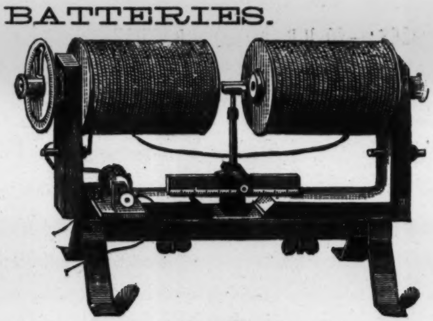

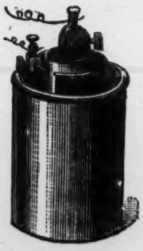

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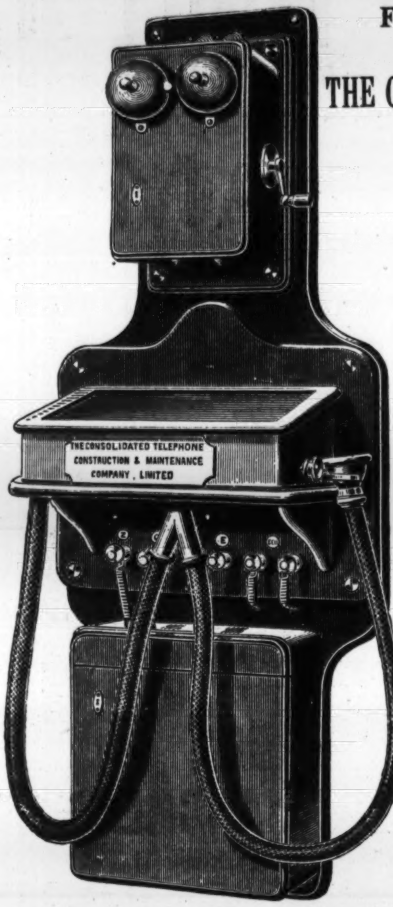
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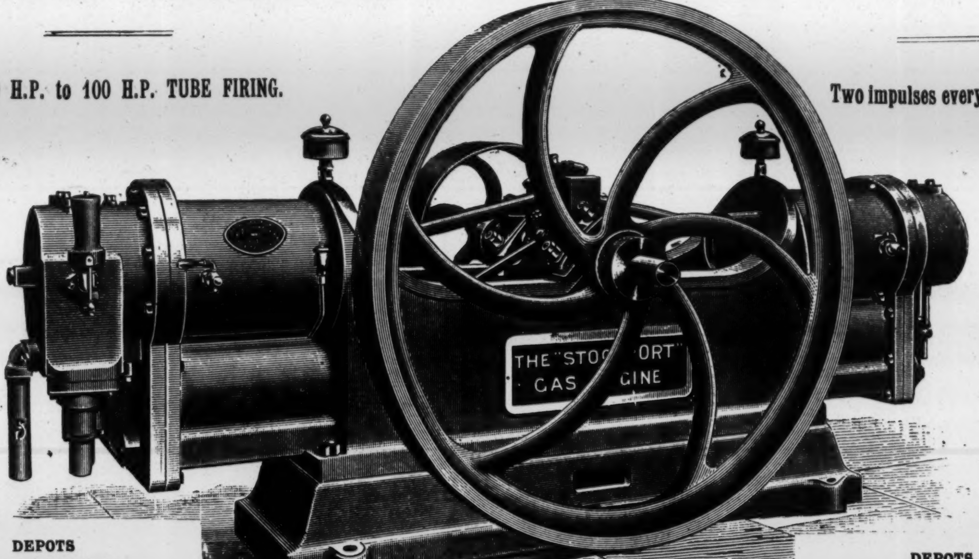

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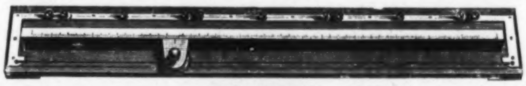

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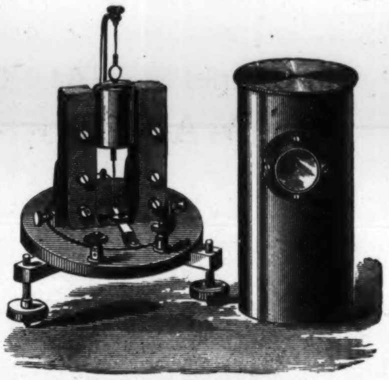

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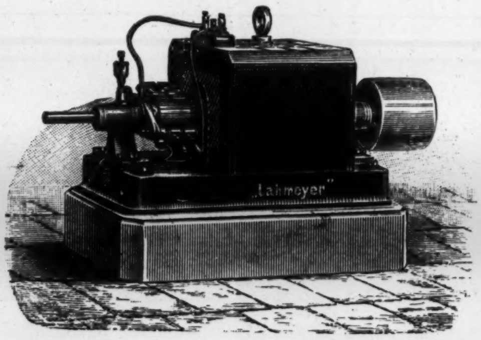

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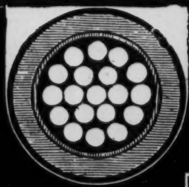

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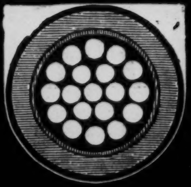

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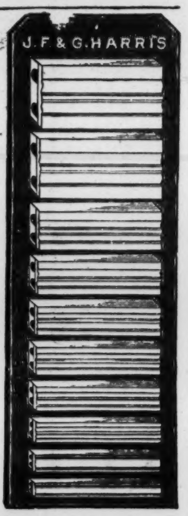

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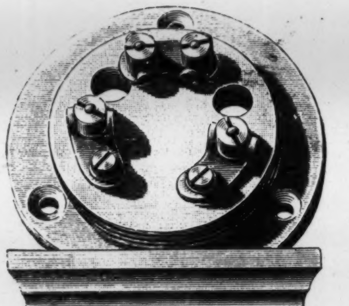

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VOL. XXVI. JUNE 20, 1890. No. 656

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THE RIVAL SYSTEMS.

IN September of last year we had occasion to discuss in a leading article the efficiency of the transformer system, and from the figures then at our disposal concluded that an amount of energy at the lamps greater than 50 per cent. of that spent in the engine cylinders should not be reckoned upon in estimating cost of production. It was shown that the usual way of estimating the efficiency of transformers was wrong, and that the ratio of the work received to the work expended when the apparatus was half, three-quarters, or fully loaded, as the case might be, was not the true commercial efficiency. The latter, it was stated, was the ratio of the watts received at the lamps to the watts expended in the primary circuits during the whole period of their connection to the mains. The figures, when we published our article, were admittedly incomplete, and we remember that a correspondent of considerable experience thought our estimate too favourable to the system. With his criticism, however, the matter dropped, and through these months we have been content to wait for more complete data.

Recently we reprinted the paper, "Some Tests on the Efficiency of Alternating Current Apparatus,"* read before the American Institute of Electrical Engineers by Dr. Duncan and Mr. Hasson. In this paper a number of very carefully-made tests of the Westinghouse apparatus were recorded, resembling those given in the Report of the Electrical Testing Bureau of the Johns Hopkins University, of which the two authors are members. This report has just reached us in a pamphlet entitled "The Commercial Efficiency of the Leading Systems of Electric Lighting," which besides the tests referred to contains the report on the tests of the Edison dynamo, made at the Franklin Institute in 1884. In the brochure are compared the efficiencies of the alternating and the direct systems on the bases of these reports, and for the conclusions reached Mr. Harold P. Brown, a gentleman of whom we have heard a good deal, is, we believe, responsible.

Now we are not going to discuss motives here. Whether Mr. Brown is interested in showing the direct current system to be the better, as his enemies would have us believe, or whether his actions are inspired solely by that uncompromising regard for truth bequeathed to American experts by George Washington, we do not know, nor are motives relevant to the subject. But we appreciate some of the figures given in his pamphlet, because results obtained from careful experiment are always of some value, and because every new truth demonstrated serves to diminish the liability to inaccuracy in our estimates. We demur to the conclusions, however, for we think the facts are open to an interpretation differing in some degree from that implied in the book.

The alternating current apparatus tested consisted of a Westinghouse 750-light machine with its exciter, and an outfit of transformers of capacity varying from 10 to 40 lights. The machines were driven by a 75 H.P. Armington and Sims engine through a Tatham dynamometer, by which the power was very accurately measured. The primaries of the transformers were permanently attached to the dynamo circuit, as in practice. There being thirty-six transformers in all, it was necessary to make observations of thirty-six secondary circuits simultaneously, and though by such multiplicity of measurements liability to error is increased, we have every reason to believe that the greatest care was taken to ensure accurate results. The secondaries were loaded up with 16 C.P. lamps, but owing to some being faulty the maximum number that could be put on was but 600. The power transmitted through the dynamometer, and the power received at the secondaries, were measured for various loads, a curve of results being plotted from which the efficiency for any load could be determined. Scaling this curve, we get for the full load of 750 lamps 78 per cent., for three-quarter load 71 per cent., for half load 60·5 per cent., and for quarter load 45 per cent. The efficiency of the transformers was also determined, and as showing the difference between large and small ones, it may be mentioned that the 40-light gave 93·4 per cent. at full, and 90·08 per cent. at half load, while the 20-light gave 89·6 per cent. and 83·6 per cent., the 10-light size giving 85·9 per cent. and 76·9 per cent.

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*ELECTRICAL REVIEW, April 18th, 1890, page 429.

So much for the report of the Electrical Testing Bureau; now for the conclusions of Mr. Harold P. Brown. It is certain that, from the figures of unimpeachable authorities, quite different conclusions may be drawn conformably to the idiosyncracies of the exponent, and we have no hesitation in saying that scientific reports are responsible for many electrical misfortunes. The scientific authority makes a report, confines himself strictly to facts, and if he knows his business, commits himself as little as possible to an opinion. He receives his fee, and the company promoter, the prospectus framer or the worldly wise director formulates from the report the necessary conclusions. If, in a moment of mental aberration, some enthusiastic physicist has spoken of a brilliant laboratory discovery as an undoubted commercial success, it is the aim of these worthies to employ his language so that the public may be taken in by it. Over and over again we have had occasion to refer to this matter. Times out of number reports have been published which, although honest in themselves, have been employed but to mislead. But is is difficult to frame a report so that it will not contain too much or too little for the men who are to use it. Now consider the results before us, and the conclusions Mr. Brown draws from them. In the paper already referred to, read before the American Institute of Electrical Engineers, the authors are very careful to point out that "when more than one dynamo is provided, the efficiency is increased by using only one of them during the times of minimum supply, and always working, as far as possible, only a little below the maximum capacity of the machines." This condition is always complied with in a properly managed station, but Mr. Brown is careful not to refer to the point. Indeed, it is his intention that all who peruse the pamphlet shall believe the output of the dynamos to vary as the total output of the station, a representation which from our point of view is of a most unfair character. "It will be observed," says Mr. Brown, referring to the tests, "that even under these favourable conditions it requires about 20 *horse-power to charge the converters and light one lamp*, but two pages farther on he shows that the percentage of full load is never less than 8·5 per cent. of the maximum, heedless, apparently, of the influence this fact has on his previous reasoning. In a station supplying 10,000 lamps there would probably be five machines of 2,500-light capacity each, one of these being reserved as spare. The least number of lamps alight, with a maximum of 10,000, would be 850, which means one machine running with about one-third of its load. If the transformers were loaded in the same proportion, the energy received at the secondaries would be, as shown by the curve, 50 per cent. of that transmitted through the dynamometer; but it must be remembered that though the dynamo is working at a third of its load, the transformers have only 8·5 per cent. of their load, and it is impossible to calculate from the data given the efficiency of the system under these, the conditions which obtain in practice. Probably the dynamo is working at an efficiency of ·75 while the transformers are giving ·4, under which circumstances the efficiency of the whole would be 30 per cent. instead of the 20 per cent. Mr. Brown gives. This is only a guess, but the main thing to be pointed out is that the result, whatever it is, must be different from that given by Mr. Brown, and seeing that the transformers are loaded to this extent for 9½ hours each day, the efficiency for this period necessarily exercises an important influence on the efficiency for 24 hours. The other machines when running would be nearly at full load, and giving an efficiency not far short of their maximum.

It is rarely that one machine only with a batch of transformers is employed, and none but a madman would make arrangements which in a central station necessitated the whole of the machines running during the day for 8.5 per cent. of the lamps. Yet on such preposterous assumptions does Mr. Brown base his arguments against the alternating current system. The Westinghouse guarantee of 50 per cent. more light per pound of fuel than could be obtained from any direct current system is of course nonsense, but so are Mr. Brown's conclusions. It is not right that this sort of thing should continue, for though engineers of experience are unlikely to fall into a trap, others, fascinated by specious arguments, may form erroneous conclusions. In every central station the arrangements must be such that they best suit the system employed; and with this brochure before us we can only come to one of two conclusions, either that Mr. Brown is misleading the public regarding alternating currents, or that he is ignorant of the manner in which alternating current stations should be arranged. Taking Mr. Brown's curve of supply, it is probable that the efficiency of the station for 24 hours should be over 50 instead of 42 per cent., and that 40 per cent. of the energy given out in the engine cylinders is recovered at the secondary terminals.

As already stated, we are not to discuss motives, and figures likely to help us in our estimating we shall always welcome, though these figures shall not be presented in fallacious shape, to the injury of particular systems, without our protesting in the strongest manner. Unfortunately we cannot, from the figures given, calculate the efficiency under the conditions of practical working, and it is to be hoped that the Bureau will make further tests, keeping those of the dynamos quite separate from those of the transformers. Until this is done we can only guess at the results. We are not interested in any particular system, but we believe in the principles of truth and justice. That the figures Mr. Brown gives violate these must be obvious, and it is for this reason we have called attention to them. We think we cannot do better than recommend their author to keep to his self-imposed duty of advocating the electrical execution of criminals.

Science Text-Books.

THE happy blending of the practical with the theoretical is coming to be a marked characteristic of the text-books which continue to be brought out by very numerous publishers; the latter have perhaps as much as any trade benefitted by the advance of science, which is a marked feature of the present age, for it is seldom that a work, however indifferently written, as long as it deals with a current subject, does not command a ready sale, and the fact that unattractive theoretical matter is rarely dealt with alone has much to do with successful sales. In compiling a book much difficulty arises from the enormous mass of matter which is at hand to select from, and the best class of work is that in which the matter, when not original (and it seldom is), is most judiciously chosen, which requires a master-hand; and though the general public is not, as a rule, able to discriminate, the teachers of science, who are always on the look-out for information, soon learn if a work is of sterling value, and by recommending their pupils to read it materially add to its success. In many cases, we believe, the popularity of a sterling work is much hampered by the unnecessarily heavy price set upon it by the publishers; certainly there is a great inequality in the prices of books of equal size, and containing apparently similar amounts and descriptions of matter.

"The Ether Theory of 1839."

THE first part of this work is said by the author, Mr. James Johnstone, of Edinburgh, to expose fundamental errors taught in Prof. Oliver Lodge's "Modern Views of Electricity," and in Part II. it is claimed that there are facts which prove that Faraday's two-force theory of electricity is false. It also contains, if the author's statement is correct, the only explanation absolutely in accordance with facts which has ever been given of the action of the Leyden jar; a knowledge of which action, says he, is necessary for the understanding of the action of all other electrical machines. On the strength of Mr. Johnstone's reasoning, it naturally follows that as he only can give a true explanation of Leyden jar phenomena, there is no other man living who understands electrical machines. Messrs. Gray, Wimshurst, Varley, Lodge, and those who are generally accredited with a slight acquaintance with static electricity, will now, doubtless, admit the error of their ways, and make reparation for their mistaken teachings.

Another Electric Traction Boom.

RUMOUR says that another company, with a nominal capital of one million pounds, is being promoted for the purpose of developing electric tramways in the United Kingdom. Contracts to the extent of £300,000 are supposed to have been entered into for the purpose of equipping tram-lines in various parts of the country. Much as we should like to see such an enterprise launched and carried through with commercial success, we still have some misgivings as to the probable immediate results. There is no doubt as to the technical possibilities; we know that tramways can be, and are, worked successfully by electricity carried through overhead or underground conductors, but we have not the faintest intimation that overhead conductors will be allowed anywhere in this country where there is any demand for tramways, and such demand can only exist in towns of sufficient population to warrant their introduction. Underground conductors, on the other hand, have never yet proved a commercial success except in one solitary case—viz., that at Blackpool. The plan has been attempted in other parts of the world, but in most cases the underground systems have been abandoned, and we still consider this method of conveying electric energy to cars as experimental. Assuming, again, that contracts to the value of £300,000 have been secured, we are pretty certain that they are not what would be considered *bonâ fide orders* from tramway companies in this kingdom, for they have neither the means nor the enterprise to enter into such contracts. If we are not mistaken, therefore, the supposed "contracts" are nothing more nor less than an offer on the part of the traction company to equip at its own cost and risk a number of existing tramways with electric apparatus, and charge the tramway companies a sum somewhat lower than that now entailed for horsing, provided that Parliament, Board of Trade, vestries, and tramway directors are all unanimous in supporting either overhead or underground conductors, to both of which any number of objections can, and certainly will, be raised. Unfortunately there are too many barriers to be broken through, and the possibilities are that the capital of the company will be expended by the time these obstacles are removed, and perhaps the very "systems" advocated by the promoters will then be obsolete. But the future of the shareholders has nothing in common with the immediate gains of vendors and promoters, and sufficient money will probably be subscribed to satisfy the "parties of the one part who agree to sell," &c. We have been accused of unfairness for persistently warning the public against certain company schemes, but we shall offer no apology at any time in the face of facts which cannot be altered by any plausible prospectuses. Within the last twelve months no less than five companies and corporations have been promoted, all of which made electric traction and its "enormous prospects" *the* great bait. The aggregate nominal capital of these concerns exceeds two millions, yet not one of them has so far shown that a single penny can be honestly earned with traction schemes. Besides these corporations we have several powerful firms of electrical engineers quite capable of coping with any demand, should it arise, for equipping electric tramways. How, we ask, if the millions already subscribed have not earned a cent, and, so far as we can see, are not likely to earn anything with electric tramways for a few years to come, is there room for another million? However, rumour is not always to be relied upon, so when we can procure authentic information we shall probably return to this topic again.

Electrical Traction.

THE paper by Mr. Mansfield on "Single and Double Trolley Wire Systems for Electric Railways," shows very forcibly the disadvantages of overhead conductors and should encourage the advocates of accumulator traction systems in this country. The writer clearly points out the drawbacks of the double wire method, which seems to be essential to American practice, if telephony is to be left free from interruption. The probabilities are that we shall not have to contend with the difficulties which engineers in the States have to overcome, but if overhead wires are ultimately allowed by legislation it is just as well to be *au fait* with the results of American electrical tramway enterprise.

SHIP PROJECTORS AND PLANT.

THE engraving, fig. 1, shows one of a number of search light projectors specially constructed by Messrs. Charlesworth, Hall & Co., Oldham, for use on small vessels in the night navigation of rivers, canals and narrow channels. The projector barrel is 16 inches diameter, rolled out of steel sheet and tin-plated, making a very strong piece of work. The mirror is one of Chance Brothers' best quality and is 16 inches diameter and 8 inches focus, fitted in a strong brass frame with a bayonet socket attached to the barrel to facilitate removal for cleaning, &c. A dispersing lens, also by Chance Bros., having an angle of dispersion of 16°, is attached by means of a hinged frame to the forward end of the barrel in order to fantail the light so as to spread it on the banks. The arrangements for ventilation are very complete, both the mirror frame and projector barrel being so arranged that a constant stream of cold air passes through, so preventing overheating of the mirror and destruction of the silvering. An instrument similar to a camera is provided at one side of the projector for viewing the arc. The hand lamp is made detachable and quite independent of the projector itself. The feed of the carbons is obtained by a right and left hand thread screw in the usual way. A screw is provided for raising and lowering the carbons, and adjustments are arranged for setting the points of the carbons from below, without having to put the hand in the barrel, as is necessary with other projectors. With carbons 20 mm. diameter and a current of 45 ampères these projectors will illuminate a distance of about 1,200 yards. Fig. 2 shows a very light and compact set of electric light machinery also made by Messrs. Charlesworth, Hall & Co., specially suitable for ship lighting (supplied with the above projectors). A set, comprises an engine with cylinders 4 inches and 5½ inches × 4¾ inches stroke, driving a Hall dynamo direct at 500 revs. per minute, with an output of 65 volts 50 ampères, the steam pressure being 60 lbs. per square inch. As will be seen, the engines are of the open frame type, the cylinders being supported on four steel columns, which also carry the cross-head slide. Both cylinders are fitted with piston valves, operated by one eccentric, the high pressure cylinder exhausting direct into the low pressure steam chest, thereby doing away with connecting pipe joints and stuffing boxes for the valve spindle. The pistons are steel castings fixed on one piston rod, of Whitworth steel, by means of cones and nuts. The piston rod glands are tightened by screwed caps, so as to prevent galling through one side being screwed more than the other, as sometimes happens with glands tightened with studs. A play of 3½ inches is allowed in the gland for any slight bend in the piston rod. The end of the piston rod is passed through a cast steel slipper slide block and there screwed by two nuts which are pinned in position. This slide block has slips for taking up wear. The connecting rod is of cast aluminium steel. Both the large and small ends are of the usual marine type. The crank-shaft is of Whitworth steel with circular crank webs and cast iron balancing discs shrunk on. In order to reduce wear, the crank-shaft and all other bearings are made of very large surface, and all parts can be lubricated while running. The dynamo is one of Messrs. Charlesworth, Hall and Co.'s inverted type. The magnets are of best soft iron, tooled all over. The armature shaft is of Vickers's steel. The resistances are as follows: armature ·21 ohms, shunt 20·65 ohms, series ·0318 ohms, and giving an electrical efficiency of 79·6 per cent.

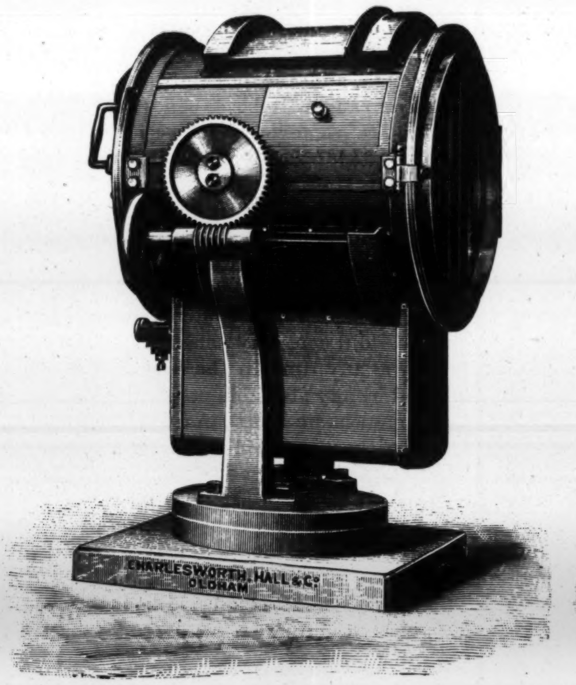

FIG. 1.

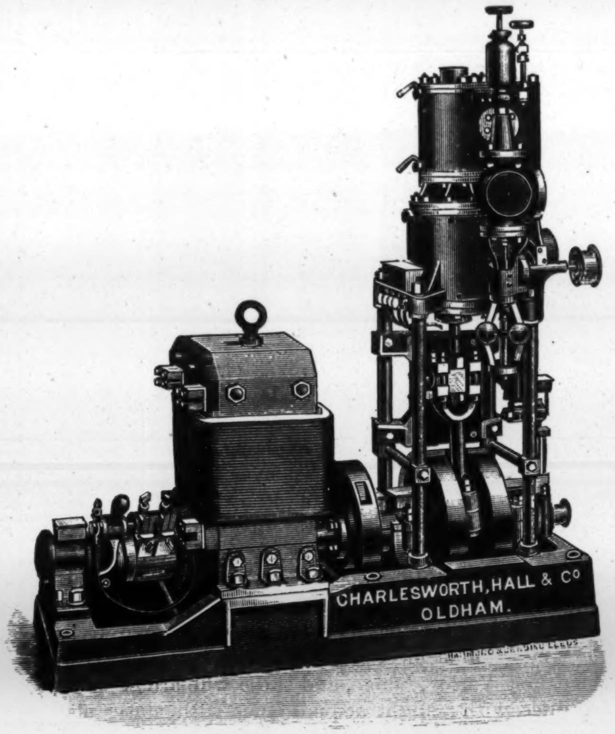

FIG. 2.

THE BLATHY ALTERNATING CURRENT ELECTRIC METER.

[FROM A CORRESPONDENT.]

THE Blathy electric meter for alternating currents, which is being made by Ganz & Co., of Buda-Pest, for their alternating current electric works, and a diagrammatic representation of which is given in figs. 1 and 2, consists essentially of a horizontal copper disc which turns very easily upon a perpendicular axle. This disc sets in motion by means of a spiral and several transfer wheels, a counting arrangement similar to those employed in gas meters.

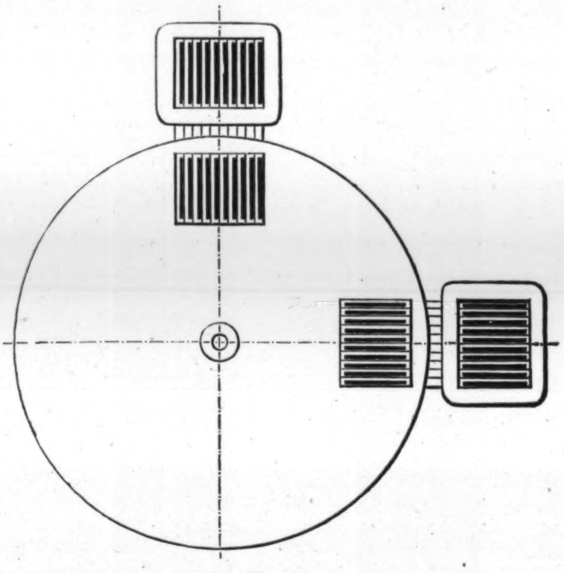

FIG. 1.

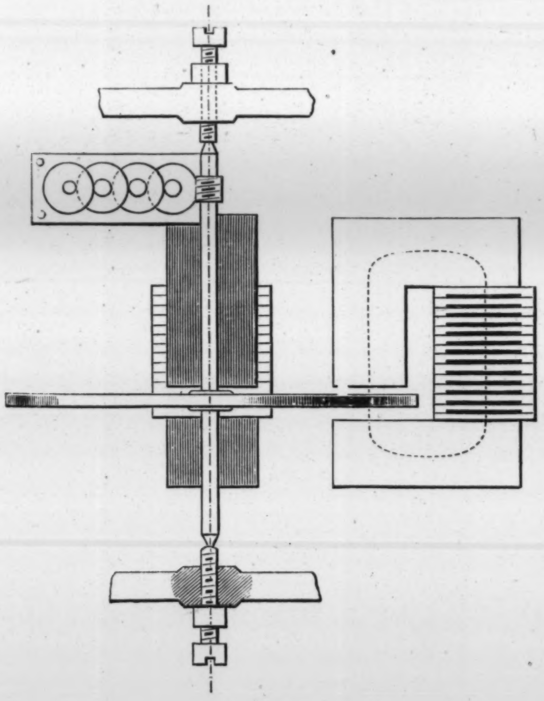

FIG. 2.

The copper disc is exposed to the inductive action of two systems of electro-magnets. One of these systems is magnetically excited by the alternating current to be measured, and the magnetism developed in this system (main current magnet) is proportional to the current transmitted. The second magnetic system is wrapped with a very thin wire and connected to the two main leads conveying the current, whereby the magnetism of this second system becomes proportional to the tension of the main current. Both systems produce in the copper disc induced currents and act upon it dynamically setting the copper disc in rotation. In consequence of the movement of the disc through the magnetic fields, currents are again induced in the same which act in opposition to the movement of the disc or counteract it. At a certain velocity an equilibrium is established between the propelling and the arresting forces; this velocity—under otherwise equal conditions is proportional to the intensity of the main current, whereby it must be remarked that with a rational distribution of the current the tension is kept practically constant. The transmissions of the wheels to the counting works are so arranged that the fingers show directly on the dial plates the number of ampère hours which have been transmitted. The accuracy of this electricity meter is quite equal to that of the gas meter (not better ?) and the simplicity of the arrangement guarantees accurate and durable work.

This electricity meter was closely tested last year by the International Commission of experts in Frankfurt-on-Main, and subjected to repeated practical investigations.

17th Series of Experiments, Friday, November 1st, 1889.

ALTERNATING CURRENT ELECTRICITY METER BY GANZ & CO.

The investigation was conducted by passing the current of a variable number of glow lamps through the counter.

The tension was observed and kept as constant as possible. The constant obtained in the last but one current of the results was obtained by dividing the differences of the positions at the beginning and end of the time of observation by dividing the number of lamps burning by the time of the observations in minutes.

No. of experiment.	Time, minutes.	Readings on d al.	Difference.	Number of lamps.	Tension, mean.	Constant.
1	2	3	4	5	6	7
17a.	0′	0				
	1′	232				
	2′	467	467	195	101·2	1 20
b.	0′	800				
	1′	1025				
	2′	1237	437	175	100·8	1·25
c.	0′	500				
	1′	695				
	2′	895	395	150	101·6	1·32
d.	0′	300				
	1′	464				
	2′	633	333	125	100 8	1·33
e.	0′	850				
	1′	990				
	2′	1132	282	100	101·5	1·41
f.	0′	300				
	1′	408				
	2′	524	224	80	101·2	1·40
g.	0′	180				
	1′	265				
	2′	348	168	60	100 6	1·40
h.	0′	450				
	2′	565				
	4′	679	229	40	100 9	1·43
i.	0′	770				
	2′	853				
	4′	936	166	30	101·2	1·38
k	0′	580				
	2′	633				
	4′	686	106	20	101·1	1·33
l	0′	740				
	4′	794				
	8′	844	104	10	101 6	1·30
m.	0′	860				
	15′	891				
	10′	921	61	5	101·3	1·22
n.	0′	930				
	7·5′	944				
	15′	960	30	2	101·5	1·00

According to the statement of Herr Blathy the meter is calculated for currents up to 150 ampères. Within the limits from 20—150 ampères the deviation is only 3 p.c., as the following table shows :—

Lamps.	Constant.	Difference.
150	1·32	0·05
125	1·33	0·04
100	1·41	0·04
80	1·40	0·03
60	1·40	0·03
40	1·43	0·06
30	1·38	0·01
20	1·33	0·04
	1·37	mean 0·04 = 3 p.c.

In judging the results it must be remembered that the meter was an experimental apparatus involving several mechanical defects, and that the consumption of current in every series of glow lamps was not quite alike. The dial is set in motion by the passage of a currrent of 0·25 ampère.

COMPRESSED AIR INSTALLATIONS ON THE POPP SYSTEM.

(FROM A CORRESPONDENT.)

THE Popp system of compressed air installations seems, contrary to all the previous expectations and predictions of the technical world, about to obtain practical results in Germany, and this, strange to say, not by the "International Compressed Air Company, Popp's System," which, as it is well known, was established by the Société d'Escompte with an enormous share capital and with its headquarters at Berlin, but by the firm August Riedinger & Co., at Augsburg, a well-known firm for gas installations. This company has acquired the Popp patents for South Germany, and is now endeavouring to procure a fruitful field for the compressed air system. According to the *Finanzherold* (a Frankfort paper), extensive compressed air installations are to be carried out in the first place in Würzburg, Bamberg, Fürth and Offenbach.

The first-named town wishes to grant a sum of half a million marks as a contribution to a compressed air installation, and to carry it on on municipal account. If, as it seems probable, the arrangement is carried out, the Riedinger Company will have the execution of the project, and as 500,000 marks are insufficient, it will undertake a large part of the expense and share the profits. A private committee has been formed at Augsburg and offers to bring forward an extensive capital. The demand has been, for the present, estimated at 400 H.P.

Negotiations are on foot at Bamberg. On inquiry there seems to be a demand for compressed air to the extent of 600 H.P.

At Fürth an agreement has been already signed. According to this the Riedinger Company will have the exclusive concession for working the compressed air installation for 40 years. The maximum price is to be 1·20 pfennig per cubic metre of air. Besides a yearly subsidy of 1 mark per 100 metres run of piping, the town is to share the profit of the undertaking as soon as the returns exceed 6 per cent. on the capital. After 11 years the town can buy the installation for 16 times the amount of the nett average profit, though this price must never be less than 15 per cent. above the cost of the installation. Application has already been made for 2,300 H.P. of compressed air. The installation must be completed in two years at latest.

At Offenbach the same agreement, with slight differences, is ready for signature. More weight is there laid on the electric light than at Fürth and the town wishes to have its entire consumption of compressed air free at a rate of 10 per cent. The applications made amount to 1,000 H.P. and the completion of the works is fixed for two years.

The Riedinger Company is also making advances to Sachsenhausen, though in conjunction with the Berlin Compressed Air Company. There are at Sachsenhausen seven large breweries in addition to other important industries.

It is announced from Paris that official experiments made with the new large installation (2,000 H.P.) have given very good results (?). The consumption of fuel was smaller than it had been estimated and the machines gave a higher useful effect (0·856) than has previously been effected (?). The compressors had been furnished by the Cockerill Company, of Seraing.

The illumination of that part of Paris (the so-called "secteur Popp") for which the Popp Company has obtained a concession, is also to be combined with the working of compressed air.

It is reported that Solignac, the electrician of the French Popp Company, has devised a new system with "undulators" and accumulators. As the company wishes to have several stations for producing cold air, there will be erected within the "Popp secteur" several stations for generating current, from which the secondary districts will be supplied and the current generators will be driven by compressed air motors. The electric machines required will be furnished by the Breguet Company, and the motors by the Société Alsacienne.

THE MANAGEMENT OF ACCUMULATORS.*

By J. K. PUMPELLY.

III.

IN speaking of the handling of storage batteries, it must be understood that all the forms of them now in the market are of the same chemical nature, and they are therefore all treated in the same way. Later on we shall describe the various mechanisms that mark the distinctions between them.

Let us pay close attention to the one we have supposedly made ourselves. According to the estimates mentioned in our last article, say there are 30 cells, of an efficiency of 100 ampères, and of an E.M.F. of 60 volts. These 30 cells are connected in series ; that is, each negative pole is firmly fastened to the positive pole of the next, and each positive to the negative, until we come to the last of the 30. Here, of course, we find a negative pole free at one end and a positive at the other. Now, to charge them, we connect the positive pole by a wire of sufficient size to carry the current we wish to charge with, without heating, to the positive pole of the dynamo, and in the same way the negative to the negative pole.

The dynamo for our use is shunt wound, and has been arranged to give a current of 15 ampères, which is continued for, say, seven hours, in which time we ought to have accumulated a capacity of 15 × 7 = 105 ampères. It may be that in our calculations we have wasted 5 ampères, not having surface enough to take them up. As to this we shall never know exactly, since if we get a successful discharge of 80 or 85 ampères, by an output of 10 ampères per hour, we shall be satisfied, and if the batteries are well made and work properly, such a discharge, at this economical rate per hour, can undoubtedly be obtained ; more surely so, if part of the discharge is made in the daytime, allowing the night to intervene as rest, for, under such conditions, the night's rest seems to add efficiency to the battery, or rather, to regain some of the working ability already taken out.

The reader or experimenter can now understand how many exceptions there are to any rules laid down for handling these erratic things ; many pages of a book could be filled with whys and wherefores on the propriety of doing this or that; and he can see how confusing and discouraging it is to the man new in the business to try to follow out such rules, even after he has made his battery, and is delighted and satisfied that it does anywhere near the work that it ought to do.

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* *Electrical World.*

The writer, having been through this, is not quoting the dicta of others, who were, but a short time ago, the only authorities on storage batteries, and each of whom expressed his own theory; but is leading the experimenter and beginner by the hand, and with him is leaning over the mysterious boxes, watching every bubble that comes to the surface, disregarding the rising fumes of sulphurous acids, or the burning touch of the fingers to the electrolyte, in the anxiety to know if every contact is perfect, and that all is mechanically right.

It is not by books that we learn to manipulate, but we do discover, by them, what the experience of others teaches, and know in this way what return we ought to have for our labour, and what, by the theories of advanced scientific students, we have a right to expect.

Since Salomons, Gladstone, Tribe and certain German scientists wrote on storage batteries, much has been discovered, and many improvements made; but after all, the mechanical combination of the lead support, with the more easily disintegrated oxides of lead, is of the first importance, and this can only be learned by experience, thought and ingenuity. There are many ways of doing the same thing, and as long as the plates of the positive and negative poles are held apart at the right distance, and all the negative plates are thoroughly connected, so that no action of the acid in the electrolyte will force them apart by corrosion, and the same is true with the positive plates, the battery will receive the charge as it should, and successfully do a certain amount of work in the discharge; but the difficulty is to make a battery in such a way that not only is this work done, but done economically and continually for months and years.

The writer, seeing in advance how important commercially storage batteries would become, has always striven to obtain durability, the lack of which has ever been a great objection to their use, and to do this he has departed from the usual form of mechanism obtaining in other batteries. But, to go back to one of the 30 cells that we have made together, it seems to be working well; the bubbles of hydrogen gas come slowly to the surface along the negative pole, the negative plate becomes gradually darker, and the positive of a constantly increasing maroon colour; and after a constant charge of 30 hours, we find this colour quite dark, and the surface of the liquid filled with sparkling dancing bubbles of gas, evidently of both hydrogen and oxygen. Then a slight milky appearance takes place, and an acidometer placed in the liquid shows an increased specific gravity, making instead of 1,150, at which we started, the record of 1,200, or even 1,210. We now conclude with safety that the battery is charged to the extent of its capacity. We disconnect it from the dynamo, before stopping it, by the aid of a quick-acting switch, through which the wires from the batteries should pass, which arrangement, by the way, we had forgotten to mention in explaining our first process of connecting. The reason for it is, that if we stop the dynamo, leaving the batteries still attached, the electromotive force that has been created in the batteries will react upon the dynamo, making a motor of it, or if the machine does not revolve as a motor, then the resistance will generate so much heat that the armature may be burned.

We are now ready to try our battery on some incandescent lamps. We have 30 cells, so we must use 60-volt lamps, because each cell acts with a pressure of E.M.F. of two volts, and collectively with 60 volts. The current needed for each lamp is one ampère, hence we might expect to make one lamp like this burn 100 hours, and ten lamps ten hours; but we find, after trying this in our first discharge, that but little over one half of this expected efficiency is the result, and, with it, terrible disappointment. Every point of contact is carefully examined, almost with a microscope, searching for the cause, but mechanically all is correct. The negative plates have lost some of their slate colour, and show more of a gray tint, as they ought according to chemical theory, and the positive plates have changed from a dark maroon to a light claret colour, which is as it should be.

Now, what is the matter? Let us think over this phase of the question, and as we are supposed to have no authority, not having read any books on the result of a first forming charge, we must rest on the theory declared by electro chemists, as to the composition of the plates after the first charge, and what is necessary to complete the charge in the lead oxides, in order to give a full efficiency in discharge. Thus reasoning, we may readily conclude this point without further aid or experimenting. A first charge, which we call the forming charge, does not fully, or even in any fair proportion, convert the litharge into a sufficient quantity of finely divided lead, nor the material on the positive plate, which was red lead, into a sufficient quantity of peroxide of lead, to produce the full percentage of chemical change necessary to do the expected amount of work.

On the strength of this reasoning we may expect better results on our second charge and discharge. Having therefore discovered, by our second, from the showing every hour on our ampère-meter, that with 30 hours of charging at the rate of 15 ampères, we have realised from the discharge only 50 ampères, we begin again, and while the same current is running through our batteries, we will explain why we talk about 30 hours' charge, when, at the rate of 15 ampères, seven hours ought to be sufficient to store up 100 ampères for work.

It was found by Planté that it needed a much larger charge of electricity to convert oxides of lead into such a condition chemically, than it does merely to charge fully formed batteries.

ARC LIGHTING AT THE MANNINGHAM SILK MILLS.

THE electric light has been introduced into the well-known silk mills of Messrs. Lister & Co., at Manningham, Bradford, for some years, and found to be of the greatest possible advantage when matching of colours became necessary, especially where such delicate shades are required, as in the manufacture of plushes, velvets, seal, and other silk productions, for which this firm stand so pre-eminent.

The requirements for the use of extra arc light in the various manufactures has resulted in the addition of so many circuits and dynamos that a rearrangement of the system lately became necessary. This system had increased by these frequent additions, up to the beginning of last year, to six series dynamos running 100 1,000-C.P. Pilsen arc lamps, and three Gramme machines, each running one 25-ampère lamp. The numerous circuits were scattered over a large area, and as the varying requirements of the several departments necessitated at times only a few lights on each circuit for all night work, the running of a large number of dynamos was frequently necessary for only a limited number of lamps. In addition to the fact that many changes had occurred in the employment of lamps of varying power, and that different incandescent lamps had become a necessity for some of the manufactures, especially in the dyeing and finishing departments, the proper regulation and working of the various circuits became more and more difficult, and as the exigencies of, and rapid increase in, the manufactures necessitated still further addition, it was finally decided by the firm to act on the advice of their electrician, and work some of the circuits on a rearranged plan with a low tension current.

In the early part of last year, acting on this advice, a dynamo was purchased from Messrs. Andrews and Preece, electrical engineers, of the Borough Mills, Bradford, which gave an output of 150 ampères and 115 volts. With this a number of arc lamps were run in a parallel series of two, together with a few incandescent lamps of 32 and 50 C.P. To give this system a thoroughly good test the dynamo was kept running nearly all day and night for about six months, and at the end of that time Messrs. Lister & Co. were thoroughly satisfied of the suitability of this arrangement to their numerous requirements, and, as a result, an extension of the plan and a consolidation of their electric light system was decided upon.

A second dynamo of the "Preece" type was purchased in the same year of Messrs. Andrews & Preece, built especially to suit the requirements of Messrs. Lister & Co. This dynamo, which gave an output of 500 ampères and 115 volts, was put down in October last in a special room set apart for it in the plush batting and shearing department, the power being obtained from one of the several mill engines which, by means of countershafting and friction clutch, was connected when required.

To carry out the consolidation of the system so that the whole might be under proper control and easy of management, the whole of the series circuits were taken down, and all arc lamps arranged in newly run circuits of parallel series of two, with the addition of 32 and 50 C.P. incandescent lamps where required. The various circuits were brought to a massive switchboard, controlled by substantial switches manufactured by Messrs. Andrews and Preece. This second dynamo was run full load for about six months, nearly day and night, and at the end of that time in the present year, the new arrangement having been proved to work so satisfactorily, it was determined by the company (now Messrs. Lister & Co., Limited) to lay down a third machine of the same capacity as the second, which had proved by its evenness and consistency of running, its excellent character, in order that the plant might be duplicated.

In April of the present year the third machine was put down by Messrs. Andrews and Preece in the old dynamo room, the power being supplied by a Robey 25 nominal H.P. engine. In this room is fixed a switchboard similar to the one in the new dynamo room, to which are connected a number of circuits running through the seal dyeing, shearing, finishing and other departments. The two switchboards are connected together by a special switch arrangement which enables the dynamos to run the circuits independently or conjointly.

At the present time the number of lamps and their candle-power distributed over the various circuits is as follows:—

Arc lamps	1,000 C.P.	100
„ „	3,000 „	6
Incandescent lamps	16 „	50
„ „	32 „	50
„ „	50 „	50
Total lamps		256

Or an aggregate power of 122,900 candles; the dynamos are as previously stated:—Two Preece dynamos, each 500 ampères and 115 volts, and one dynamo of 150 ampères and 115 volts.

The two large dynamos are so arranged that each can work separately on its own special circuits, or either dynamo can work its own circuits as well as those of the other. For example, if the mill engine driving the No. 1 large dynamo be stopped, or not requiring to run all night, then the No. 2 dynamo, driven by the separate engine, takes its place and runs the necessary circuits by connecting the two boards together. The special connecting switches between the two switchboards are arranged as plug switches, and can be only connected up for one engine to run the circuits jointly at the same time. As there is only one set of plugs it is impossible for confusion to happen. The arrangement is excellent and, in practice, is found to answer admirably.

The working of the machines can be so arranged that when all the lights fixed are required to be run, the two dynamos will be working their own respective circuits; when the load is a light one the switchboards can be properly connected, and one machine only do the work. When the lighting requirements at night are insufficient for keeping one of the large machines going, the third machine of 150 ampères capacity is utilised, so that now under the new arrangement of working as suggested by the company's electrician, not only is great economy effected, but the system of working is greatly improved and rendered more efficient and kept under better control. We have had an opportunity of inspecting lately the whole of this interesting installation, and are glad to learn that the utility, comfort, and advantages of the electric light at these important mills have been proved to be so great that a still further extension is in contemplation. The whole of these alterations and extensions have been well and carefully carried out by Messrs. Andrews and Preece, Limited, under the direction and the supervision of Messrs. Lister and Co.'s electrician, Mr. Edwin Preece, who has been in their service for many years, and who may be congratulated upon the excellent results obtained from his plans and suggestions.

This installation, if not the largest, is one of the most important in the manufacturing districts of Yorkshire. The Manningham Mills are well known as being of exceptionally great extent and importance.

ELECTRIC LIGHTING IN SOUTH-WEST LONDON.

ELECTRIC lighting in the South West of London appears to be assuming a more definite form. For some years past a small plant, consisting of dynamo and gas engine, has been in constant operation on the premises of Messrs. Francis and Son, of 446—450, Brixton Road. The dynamo supplies current to a number of arc and incandescent lamps installed in and outside of the firm's shops, and also to various lamps which illuminate some of the adjoining shops. This installation has worked very satisfactorily since its inauguration. A little higher up the Brixton Road the Brixton Estate has erected three large blocks of houses and shops, extending from the main road to Brixton Railway Station. These are handsome buildings, constructed to meet the local requirements. They are divided by a street termed Electric Avenue, and by another thoroughfare called Electric Lane. The former will be lighted with Fyfe-Main arc lamps of 2,000 C.P., and will form one of the most attractive features in lighting in London. The shops and houses have already been wired, and a small central station has been erected on the estate in the rear of the avenue. An interesting feature in the station is the plant, which was formerly employed in connection with the illumination of the works of the Forth Bridge during construction. The engine is of the Davey-Paxman horizontal type; but the dynamos have not yet been installed, owing to the buildings not yet being tenanted. It is proposed to have telephonic call rooms in the outlying districts, embracing a population of over a quarter of a million, so that orders may be rapidly transmitted.

Near the Kennington Park end of Brixton Road, between Offley Road and South Island Place, a large number of old houses have been demolished, and in their place are being erected many shops and stores. These are being divided by a handsome avenue, which is denominated Electric Promenade, which will extend from the Brixton Road right through to the Clapham Road. These buildings and the avenue will be electrically lighted, and the current, as in the former case, will be supplied from a central station. In addition to these two instances, there is the probability of electric lighting extending at Clapham when the traction business of the Electric Tramcar Syndicate is in full operation. Taking the subject generally, the inhabitants of the south-west seem to be greatly in favour of electric lighting in preference to the bad quality of gas which is supplied in that district.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

SECOND SERIES.

(*Concluded from page* 670.)

IN the last contribution it was pointed out that Prof. Lodge's own experiments demonstrate clearly that Leyden jar discharges are completed more quickly through solid copper conductors of large section than through copper conductors of smaller section, notwithstanding the inertia encountered is greater when the section of a conductor is increased. It was also pointed out that within the limits embraced by Prof. Lodge's experiments the superiority of copper over that of iron for effecting rapid discharge was so great that the Leyden jar was observed to discharge in less time through a No. 19 B.W.G. copper wire than through a No. 1 iron wire. It was also further pointed out that the simple theory developed in the course of this article was capable of explaining in a natural common sense manner all that which was observed in connection with the "alternative path" experiments.

It is thought advisable to make a few further remarks in reference to the rate at which statical discharges fall down to zero after the maximum flow has been reached, because although very full consideration has been given to the inertia resistance opposed by conductors at the time statical discharges are rising from zero to the maximum flow, our mathematical physicists (it seems to the writer) have overlooked *altogether* that the inertia encountered represents a storage of energy which contributes to the rapidity of the fall from the maximum flow down to zero. A long submarine circuit is an example of a Leyden arrangement, in which the conditions that determine the rate of fall from the maximum discharge to zero are the very reverse of those which prevail when ordinary Leyden jars are discharged through short solid conductors of low conductive resistance.

In a submarine circuit the magnetic inertia and self-induction is relatively small, and has very little influence in determining the rate at which statical charge can become accumulated, and it has also practically very little influence in determining the rate of fall at which the cable discharges, the reasons being that, in a submarine circuit, the conditions are very favourable for the accumulation of statical charge owing to the large extent of surface which forms the inner and outer coatings of the Leyden arrangement; at the same time the conductive resistance of the copper core is relatively great, and consequently discharge occurs very slowly, the time required for complete discharge being theoretically infinitely great. In a lightning conductor it is inertia resistance encountered, that determines the rate of discharge. In a working submarine cable, the outer surface of the conductor forms the inner coating of the Leyden arrangement, and the conductor is connected through the instruments to the earth, and therefore there is a good electrical connection always existing between the two oppositely charged coatings. Conductive resistance is the *only* insulation, and it is *such insulation* that enables a statical accumulation of charge to occur, and it is also conductive resistance which determines the rate of discharge.

Attention has been already called, through the medium of this journal, to what was observed in connection with the recent electric welding experiments, performed at the Institution of Civil Engineers, as supporting the writer's contention that transient currents pass through the mass of a conductor, and that they are not crowded solely in the outer skin.* But it is thought advisable to make a few brief remarks as to what occurs when electric alternations generated by a transformer pass through an iron conductor. The action of the secondary circuit of a transformer is fairly comparable with that of a brattice dividing a mining shaft, which enables two currents of air to be transmitted freely through the shaft in opposite directions at one and the same time. If the secondary circuit of a transformer be closed through itself, and alternations be transmitted through the primary circuit, there will then be practically *no inertia resistance* opposed in the transformer, what resistance is encountered will be *conductive resistance only*. In the electric welding experiments, the iron bars heated were included in the secondary circuit outside the transformer, and the iron bars themselves opposed very great inertia resistance to the electric alternations, the conditions which prevail in the iron bars resembling that of a mining shaft when the brattice becomes destroyed. Under such conditions in a mining shaft, the currents of air travelling in opposite directions come into collision with one another, and instead of transmission, a local transformation of energy occurs, precisely the same thing happens when electrical alternations are being rapidly transmitted, through an iron bar more especially, but also in a less degree through any solid conductor; at each alternation inertia has to be overcome, resulting in a transformation of energy into magnetism, and before the demagnetisation of the one alternation has had time to be completed, an alternation in the opposite direction occurs, and it results in eddy currents being set up in the iron bar, bringing about a local transformation of energy into heat; the resistance which is opposed as a consequence of the eddy currents set up in the iron is very great, but transformers can accommodate themselves in a considerable degree to the resistance encountered, and what results is an increased voltage, with a corresponding ampère reduction of the alternate currents developed in the secondary circuit of the transformer, and the outcome is that the transformation of energy into heat is confined in a greater degree to the iron bar desired to be heated than would otherwise occur.

The writer annexes an extract from Prof. Lodge's paper of 1889, read and discussed at the Institution of Electrical Engineers, and he does so lest it might seem that he has incorrectly stated the conclusions mathematicians have arrived at. The passage referred to reads as follows:—"A few words may suffice to explain the nature of the impedance which alternating currents meet with in passing through a conductor, and of the reason why *iron is as good as, or even better than copper for the purpose of conveying currents alternating with extreme rapidity*"—the italics are writer's own—but if what is stated in the passage quoted be true then copper bars should be more readily heated by an alternating current welding machine than iron ones, and iron conductors might be substituted with advantage for the copper mains now employed in connection with high pressure alternating electric systems.

To practical common sense it seems impossible to understand that mathematicians can in any other, than in an academical sort of way, really believe that iron is capable of transmitting rapid electrical alternations as efficiently even as copper, not to say more efficiently. That mathematical reasoning, having for its basis the newer electrical theory, leads Prof. Lodge to such a conclusion is evidently so from his published statements, and one of the reasons he has given for preferring iron to copper is its higher melting point and less liability to be fused.

For the protection of buildings Prof. Lodge has suggested that in place of a single point the roof of the building should be surrounded with galvanised iron wire, bristling with points, and he seems to think that such an arrangement would help to bring about discharge quietly; the observations made by the late Andrew Crosse with an exploring wire afford evidence that atmospheric discharge does take place silently in a very large degree, and it seems probable that discharge by lightning is the exceptional form in which discharge occurs between the clouds and the earth. In a passage too long to quote in its entirety, Andrew Crosse states that "when the edge of a thunder cloud is perpendicular to the exploring wire, a slow succession of discharges takes place between the brass ball of the conductor and one of equal size connected with the nearest spot of moist ground. I usually connect a large jar with the conductor which increases the force of, and in some degree regulates the number of explosions." He goes on to say "that after a certain number of explosions, say, of negative electricity, which at first may be 9 or 10 in a minute, a cessation occurs of some seconds or minutes, as the case may be, when an equal number of explosions of positive electricity takes place; and he further states that the alternate discharges of positive and negative electricity increase in rapidity as the cloud passes over the exploring wire, "until a regular stream commences, interrupted only by the change into the opposite electricities," and that "when the *middle* of the cloud is overhead a crashing stream of discharges takes place, the effect of which must be witnessed to be conceived."

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* See ELECTRICAL REVIEW, May 23rd, 1890, article on Sir William Thomson's paper, read before the Royal Society, Edinburgh.

The surface of any single building is so small, relatively, and the distance intervening between it and the cloud is so large that the writer is disposed to think it can practically make very little difference whether there be one or numerous points, providing the single point is a considerable height above the highest point of the building. The writer tried the experiment a great many years ago of substituting a single point for the comb of a cylinder frictional machine, and he found the single point to act as efficiently as the comb, a Leyden battery, consisting of a number of jars, being charged to the discharging potential with the same number of turns of the handle, when there was only a single point, as was the case with the comb, which consisted of a row of points.

A thunder cloud the writer considers to be fairly comparable to a reservoir of water situated on a height. It sometimes occurs that owing to the pressure of the water the retaining walls of a reservoir give way; leakage of water takes place usually before the actual catastrophe, and such leakage assists to break down the cohesion of the structure, which gives way at first slowly, and afterwards rapidly, letting loose a flood of destructive energy. The fact that there are drains in the valley will have no influence whatever, so far as the bursting of the reservoir is concerned, but their capacity to carry away the flood, when it does come, is of very considerable importance in mitigating the destructive consequences. Now a thunder cloud is, after all, only a reservoir of energy, the retaining wall being the dielectric atmosphere separating the clouds and the earth. All the time charge is being accumulated, more or less discharge is quietly occurring; but if the potential accumulates faster than it is being lowered, the electrical pressure becomes sufficient to break down the cohesion of the air molecules; before this actually occurs the electrical leakage usually increases, and such electrical leakage acts in a very similar way, as the leakage of water through the wall of a reservoir subjected to great pressure, and it helps to undermine the dielectric wall which gives way at last suddenly, the heat then developed in the path of discharge greatly reduces the resistance opposed, and a flood of energy is poured down which it is the purpose of a lightning conductor to carry harmlessly away. Were it not for the great reduction of resistance which occurs in the air path immediately after it has given way, the whole of the energy accumulated in a thunder cloud would be dissipated in forcing a passage through the air. As it is, seeing the enormously greater resistance of a mile of *even* highly heated air compared with that of a few hundred feet at the outside, of a metallic conductor, and seeing also the very imperfect conductivity of the surface of the earth, as well as that of the clouds, by far the greater amount of energy which becomes dissipated at the time of a lightning discharge must be spent in the clouds themselves, the air path, and also the earth; but nevertheless, owing to the reduction of resistance in the air path, which occurs in the very act of breaking it down, a flood of energy is liberated which the lightning conductor is designed to deal with.

Now, certain of our mathematical physicists would have us believe that the flood of energy, which after the cohesion of the air molecules has been broken down, forces its way through a path of great resistance, instead of going through the mass of the lightning conductor, passes down an outer skin of microscopic thickness, and oscillates backwards and forwards between the clouds and the earth. They would like to persuade us that electricity and energy, whose rate of motion (as neither possess weight, *i.e.*, inertia) would be infinitely great were it possible to obtain a conductor which opposed no resistance, and whose actual speed, as it is, is determined *solely*, by the resistance encountered, passes up and down the conductor, and further they call upon us to believe that an entity not possessing inertia is capable of oscillating, although they admit, at the same time, that *all* oscillation involves inertia, *i.e.*, weight; and why is this demand made upon our credulity? Simply because the mathematical development of a theory, propounded by a very eminent physicist, seems to demand it, and it would really seem

> That when a theory's in the case
> All common sense must then give place.

The efficiency of a lightning conductor, in the opinion of the writer, depends upon its low magnetic inertia and specific conductive capacity; and, as the magnetic inertia of copper is very much less than that of iron, whilst its conductivity is six times greater, copper he considers to be a very superior material to iron for the construction of lightning conductors.

The actual resistance opposed by a lightning conductor, compared with that encountered in the air path, is so very small that a copper wire of comparatively small section is sufficient to conduct harmlessly away ordinary lightning discharges, but Prof. Lodge's *own* experiments, demonstrate *clearly*, that solid copper conductors of large section are more efficient than conductors of smaller section, and the fact that the points of a lightning conductor are occasionally fused is evidence that conductive resistance is an element which should be taken into consideration.

The most efficient conductor, according to the writer's views, is a multiple copper conductor, constructed either of ribbon copper or a number of wires, the writer would prefer wire simply, because it is more practical, and can be stranded; but a series of parallel copper ribbons, the writer is disposed to think, would be theoretically more perfect.

In a multiple conductor the energy of the discharge is exerted more wholly longitudinally than in a solid one. It is not that such disposition of the conducting material reduces the actual magnetic inertia, but because the mutual induction between the molecules, magnetised in the act of discharge, is very much reduced, and the general outcome is, that the resistance which is opposed, is in a much larger degree conductive resistance only, and a single multiple conductor of large section should have less inertia resistance than single wires of smaller section, or a single copper ribbon.

In Prof. Lodge's "alternative path" experiments, it was observed that when a copper wire of large section formed the path of discharge (L, fig. 23), the Leyden jars discharged through it more rapidly than was the case when the L path was of smaller section, it was also observed that when the section of the path, L, was increased, the spark produced at B, *admittedly* due to to inertia in the conductor, became increased also, so there was positive evidence afforded of greater inertia encountered, along side of greater rapidity in the rate of discharge. The explanation given by the writer of this, at first sight, paradoxical phenomenon, was that the inertia encountered in the path of discharge, represented a transformation of energy into magnetism, and the larger the section, the greater such transformation, and further, that the transformation of energy into magnetism represented energy stored in the conductor, which was given out as current immediately after the maximum flow has been passed, and helped to increase the rapidity with which the discharge was completed, and he also expressed the opinion that the larger the section of the conductor, the longer the interval of time requisite for the Leyden jar discharge to rise from zero to the maximum flow, but it was stated that such increased interval of time was more than made up for by the greater rapidity in the completion of the latter portion of the act of discharge, assisted as it was by the greater conductivity of conductors of larger section. At the time the writer penned the explanation here referred to, certain thoughts haunted him, but he considered it would be better to defer what he felt tempted to say, to the concluding portion of the article, and what is now put forward, he wishes to be regarded in the light of a speculative suggestion deserving consideration. The thought which has obtruded itself is, that, seeing what is occurring at the time a Leyden jar discharge is rising from zero to its maximum flow, is simply a transformation of energy into magnetism in the path of discharge, may not such transformation occur more rapidly when the section of a conductor is increased ? Should this be so, as he is disposed to belive, then the greater section of the conductor, the greater the percentage of the energy associated with the statical charge, that would become transformed into magnetism, and the sooner, also, that the demagnetisation of the conductor would commence. According to this view, the transmission of *the energy* accumulated in connection with the statical charge would proceed from the charged Leyden jar more quickly from the very commencement of the discharge until its completion.

It must not be overlooked that the current developed by the act of demagnetisation of the path, L, is produced *solely* in this path, the circuit being completed across the air space, B ; and, further, that such current is developed by energy limited in quantity, and accumulated, in the first instance, in the Leyden jars. Now, seeing the energy of a charged Leyden jar is a limited amount, it cannot become transformed into an unlimited quantity of magnetism, and that being so, the writer is of opinion that what is now commonly considered as inertia resistance is *not* resistance in any true sense of the term, and the logical sequence of what has just been said seems to be that the inertia resistance of a conductor is *limited* to the *amount* of energy it is opposed to. In the working theory developed in the course of this article, the inertia of matter which is inseparable from it, which can neither be added to nor taken from matter, and which constitutes matter's most distinguishing property, has been described as negative energy ; and, further, that in all physical phenomena or transformations of energy, the positive and negative energies *must* be necessarily balanced, as the performance of a physical act is a combination of positive with negative energy equally with what is understood as a chemical combination. To sum up the the matter briefly, the writer would state that the conclusion he arrives at is, that what is now regarded as inertia resistance, is *not* resistance in any *real* sense of the term, and he feels very confident that if the "alternative path" experiments were repeated with copper, L, paths of uniform length, but of varying section, employing statical charges of uniform quantity and potential, that if the experiments were commenced with, L, paths of small section, increasing gradually their size, the spark at B would in the first instance be found to increase with each increase of section, but that *the percentage* of increase of the spark would be also found to *decrease* rapidly after a certain size had been reached, and a stage would be arrived at, where the spark produced at B reaches practically the maximum amount obtainable, and any further enlargement of the conductor after this, would not perceptibly increase the spark at B.

The truth of the writer's reasoning derives support incidentally from the recorded results obtained by Prof. Lodge. It will be seen by a reference to the extract from the published report of the Dr. Mann lectures, which appears in the issue of this Journal of June 13th, that when the L paths were iron wire, the specific magnetic inertia of which is so very much greater than that of any other conducting material, the critical length of the spark at B was observed to be the same with iron conductors of No. 1 and No. 18 gauge, the sectional area of a No. 1 wire being somewhat more than forty times as great as that of a No. 18 gauge wire.

The writer has now said all that he thinks it necessary to put forward at the present moment in reference to the so-called advance in electrical theory. The issue is a very plain one—either the writer is *absolutely* wrong, or the newer development of theory has no claims *whatever* to be considered an advance on the simpler theory of the older school. It must be admitted that the writer's criticism has been suggestive, and in a measure constructive, for he has not hesitated to state what he has considered to be the logical deductions of what has been brought forward, and he thinks he can fairly claim that in the course of this article he has again, and again opened up fresh ground, which has not hitherto been explored by physicists. He has endeavoured to look at the facts of physical science from as many points of view as he has found possible, and certainly in more than one instance from points of view which have wholly escaped the attention of the mathematical physicist. His criticisms cannot be regarded as captious, for he has all along kept touch with his base of operations, all the reasoning being based on facts and principles admitted by physicists generally.

In the writer's opinion the laws governing physical phenomena are absolute, and the principle, energy, which is primarily concerned in all the activities, never shirks or tries to evade its opposing principle, inertia, by passing down the outer cuticle of matter, but, on the contrary, that it deals with inertia very much in the same way as, say, atoms of hydrogen do, when they chemically encounter atoms of oxygen.

The writer considers he has given a true and full explanation of all that was observed in connection with the "alternative path" experiments, and if he has been able, as he thinks, to turn these experiments to a more useful account than their own author, it may be certainly fairly contended that the simple common sense theory he has inherited is a safer guide, and a more efficient instrument of analysis, than what is admitted to be a "singularly complex" theory, demanding the *very* highest mathematics for its elucidation.

Although the writer has brought forward what he himself regards as all-sufficient reasons for the faith he holds, he admits frankly that the *experimentum crucis* has not yet been tried, but in his criticism of Sir William Thomson's paper, lately read before the Royal Society, Edinburgh, he has pointed out how simply the question in dispute, viz., whether transient currents are confined to the outer skins of conductors, or whether, as the writer contends, they pass through the whole mass, can be determined by absolute experiment.

It is not too much to say that in these days of practical applications of science, when scientific Professors leave their professorial chairs and assume the position of practical advisers, that any unsound science, especially if put forward sensationally, is likely to be mischievous, at the very least, as the square of the scientific status and enthusiasm of the speaker, multiplied by his faith in the infallibility of theory.

As far back as 1858 it fell to the writer to point out the errors of mathematical physicists in respect to the transmission of signals through submarine circuits by means of electric alternations, and this he did by showing the true bearing of Faraday's laboratory researches. Our mathematical physicists were publicly invited to reply to his paper read before the Institution of Civil Engineers, but they did not avail themselves of the opportunity afforded, and the only criticism was a sneer from Cyrus Field that the writer was a "young man" who had gone directly in the face of Faraday. Both Sir William Thomson, as well as Prof. Lodge, have assumed public responsibility in respect to the so-called advance in electrical theory. Sir William Thomson must know from experience the great amount of mischief which is likely to result, when scientific enthusiasm is publicly and sensationally indulged in.

The writer, in conclusion, invites Sir William Thomson, and also Prof. Lodge, to take some public notice of the criticism contained in this article; if what has been brought forward is considered to be unsound, then, on public grounds, it deserves refutation; but if the main contentions of this article are unassailable, then it is not too much to say that both Sir William Thomson and Prof. Lodge owe it to the public, as well as to themselves. to let it be publicly known that the recent mathematical developments of the newer theory are to be considered, as purely academical conclusions only, of no real value to the practical man.

THE ROCHESTER AGRICULTURAL SHOW.

THIS year's meeting of the Bath and West and Southern Counties Society, which has for its object the encouragement of agriculture, arts, manufactures, and commerce, was held at Rochester from the 5th to the 10th inst., and was well attended by both exhibitors and visitors. From an electrical point of view there was nothing shown to call for special mention, but many well known engineering firms were represented.

Messrs. Marshall, Sons & Co., Limited, exhibited, among others, a 6 H.P. portable engine, to work at 80 lbs. pressure, and an 8 H.P. traction engine. On the stand of Messrs. Priestman Bros., Limited, were two of their well-known oil engines, one being portable of 11 H.P. and the other of 2 H.P. These petroleum engines are suitable for driving dynamos, &c. Two stands were occupied by Messrs. Ransomes, Sims and Jefferies, Limited, who had a number of exhibits. There were shown an 8 H.P. portable steam engine, a 6 H.P. agricultural locomotive, a 3 H.P. vertical engine and boiler, &c. Messrs. Aveling & Porter had five exhibits, one being a traction engine and Brush Victoria dynamo combined. This combination is nearly always on view at this kind of show. A thrashing machine and an 8 H.P. traction engine were the only exhibits shown by Messrs. Ruston, Proctor & Co. Neither Messrs. Robey & Co. or Messrs. Davey, Paxman and Co. were represented. A large stand was occupied by Messrs. W. H. Willcox & Co., who showed an assortment of engine and machine oils, engine packing, hose, belting, engineers' tools, steam fittings, &c.

Mr. E. S. Hindley, of London and Dorset, showed several vertical engines and boilers and horizontal engines with vertical boilers. Four Otto gas engines were exhibited by Messrs. Crossley Bros., two Stockport gas engines by Messrs. Bilbie, Hobson & Co., for Messrs. J. E. H. Andrew & Co., and one Fielding vertical gas engine was on view at the stand of Messrs. Fielding & Platt, of Gloucester. We hope shortly to give a description of this engine, as also of an electric weighing machine, which was shown for the first time at the Paris Exhibition last year.

The show of the above Society, although on a smaller scale than that held annually by the Royal Agricultural Society, has been a success, and has resulted in bringing forward several new exhibitors this year for the first time.

THE WARD AND SLOAN BATTERY.[*]

By Prof. A. E. DOLBEAR.

IN the *Electrical Engineer* of June, 1888, there is an excellent paper on galvanic batteries, their possibilities and limitations. There are numerous tables giving the calculated and observed electromotive forces due to various elements and liquids, &c., and among these the highest given for any combination is that due to magnesium combining with chlorine, namely, 3·1 volts. The calculated E.M.F. being 3·24 volts. The highest E.M.F. obtained with zinc is 2·2 volts when combining with hydrochloric acid.

On looking over these carefully-prepared tables and considering their meaning, one would be quite likely to come to the conclusion that the ground had been so well worked over that it would be a waste of time for one to attempt, with common materials, to produce a cell that should be superior to those already known. Of course, if magnesium was commercially available so as to be a competitor with zinc for battery purposes, much higher efficiency could be obtained, but if one has had to depend upon zinc and common reagents, there has not been anything to encourage him to think that any improvement was possible.

For about 50 years we have had the Grove cell and the Bunsen cell (though I think that Silliman of Yale College used this form and described it before Bunsen), these having electromotive forces of about 1·8 and 1·9 volt, respectively; and we have had the bichromate cell with 2 volts.

Any considerable departure from these in the way of higher electromotive force was not to be expected. Electricians will therefore be pleased to know of a galvanic cell nearly 50 per cent. better than either of those mentioned. I examined this cell some time ago and announced finding an electromotive force of 2·87 volts, whereat one of the English electrical papers declared that it did not believe it.

As it was subject to the condition of obtaining a patent, it was at the time inexpedient to give the particulars about the cell. As that condition no longer obtains I give the directions for making such a cell, and anyone may verify the statement for himself.

The zinc is put into a solution of sodium hydrate NaOH, and the carbon into a porous jar containing strong nitric acid, HNO_3, and chromic acid, CrO_3, to which is added some common salt. The proportions of these are: To one-half a gallon of HNO_3 add one and a half pounds of CrO_3 and one pound of salt. The internal resistance of a cell depends upon its size, &c., and the above quantities are for a cell 12 × 12 × 9 inches. The zincs being the equivalent of 24 rods half an inch in diameter, such as are in common use in Leclanché cells; the carbons are the equivalent of 50 electric light carbons.

That was the way these elements were disposed in the cells I examined. Such a cell had an internal resistance of about one-tenth of an ohm, and was capable of giving a current of 10 ampères, or more, all day. One such cell gave 10 ampères for 30 hours continuously, when its internal resistance was found to be but ·13 ohm, and its electromotive force 2·32 volts.

I have since that time measured such cells having 2·9 volts.

The chromic acid made from alkaline chromates is better than the ordinary, and that manufactured directly from the chromate of iron has been found to give decidedly better results than that ordinarily to be bought. The discoverers of this cell are Messrs. Ward and Sloan, of Boston, who hit upon it by a system of trials with various chemicals. Such a hotch-potch would not likely be suggested by any theory of things, and leads one to think it may not be unlikely that other common stuff lying round may have in it the possibility of still further increasing the usefulness of the primary battery.

The Royal Society.—The following paper, among others, was to be read last night:—H. Wilde, F.R.S., "On the Causes of the Phenomena of Terrestrial Magnetism, and on some Electro-mechanism for exhibiting the Secular Changes in its Horizontal and Vertical Components."

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[*] *Electrical Engineer.*

[*] "The Possibilities and Limitations of Chemical Generators of Electricity." By F. B. Crocker. A paper read before the American Institute of Electrical Engineers.

ELECTRICITY IN THE AMERICAN NAVY.*

By GILBERT WILKES, U.S. Navy.

I HAVE taken as my title "Electricity in the Navy," and shall give in my paper the general conclusions derived from five years' more or less intimate connection with the application of electricity in our naval service.

The electrical engineer has little to do with the placing of the dynamo room, which is of necessity governed by the arrangement of the ship as a fighting machine. I shall, therefore, merely consider the power and apparatus of the plant, commencing with the engines.

Both in this country and abroad compound condensing engines have been used, some having separate condensers, some exhausting into the main condensers of the ship; but the preference seems to be in favour of simple double acting, high speed engines, the reason being that the power used for electrical purposes is so small in proportion to that of the main engines of the ship (only about an average of one per cent.), that the saving does not pay for the additional complication and cost. However, with a given plant, the engine should be constructed to allow little variation of speed under large changes of steam pressure, in order to take advantage of the main condenser when possible.

In our service both horizontal and vertical engines are now in use, the preference in some cases being the result of the shape of the available space. No data has yet been obtained as to the most economical type, but both are doing good service, the mishaps having been due to accidents. Of late years all of the engines put in for electric lighting have been high speed, the largest of about 25 horse-power and running at 400 revolutions.

The important points in the consideration of a marine dynamo are :—

1. It should be direct driven. The reasons are obvious, as not only is the space taken up by the belting valuable, but in a sea way the danger of running belts must be considered, especially when it is taken into account that naval vessels are fighting machines, and the possibility of accidents must be reduced to a minimum.

2. It should be compact. This is a natural extension of the above. Even now it is difficult to find room for all the machinery, stores and ammunition, besides providing room for berthing the crew on a modern man-of-war.

3. It should be free from liability to injury by salt water, and not too subject to mechanical damages.

In this respect there remains room for considerable improvement, the latest dynamos now better filling this requirement than did the old "L" machine on the *Trenton* in 1883, the first dynamo afloat in our navy, and which ended its useful career in the great storm at Samoa last year, when it ran until the water had put out the fires under the boilers.

On board ship salt water and damp air get everywhere, and within the last year a number of cases of slight burn-out have occurred in armatures, which, when installed, measured high in the hundreds of thousands of ohms insulation. The dynamo should not be easily harmed. The dynamo room is now always low down in the ship, under the protective deck (if there is one), and when the light is not in use the room is very dark, rendering careful inspection difficult.

4. The dynamo should have small effect upon the compasses. This point has received little attention, though it is a matter of great importance, as the effect on many vessels is so large that, in order to work up the day's run, it is necessary to know the hours during which the dynamos have been in operation. Complete deviation tables are, therefore, necessary for the two cases. In different types of dynamos the effect with a 20 horse-power machine, at a distance of 12 feet, will vary from less than one-twentieth of the horizontal component of the earth's magnetism to several times the strength of the horizontal component. The latter is, unfortunately, rather the rule than the exception, and, in consequence, the position of the dynamo room has to be well borne in mind in locating the standard compass.

5. It should be easy in running, and require but little attention. The machine should be non-sparking, under constant load, and also be able to stand sudden large changes of load with little sparking. This is necessitated by the fact that the dynamos now supplied for incandescent lighting are also used for search light work, and the conditions are aggravated by most of the search lights having hand regulation only. Thus, with a 200 ampère machine, not only are from 50 to 100 ampères thrown suddenly on and off, but, at the moment that the operator at the projector brings the carbons together, the dynamo is suddenly called upon to deliver over three-fourths of its total capacity.

6. It should be efficient and run cool, the former in order to avoid the waste of energy and a corresponding amount of the coal supply, and also in order to avoid overheating. The dynamo rooms on ship board are, at best, warm, notwithstanding the motor fans, which are now usually supplied, and thus the safe limit of extra heating is reduced. At the same time consideration for the attendants requires that the cramped space be kept as cool as possible.

7. The dynamo should maintain a constant potential at all loads. This is, of course, accomplished by compounding, and, as there is only about 3 per cent. drop, it is usual to compound exactly, or to only overcompound enough to allow for the decrease in the engine's speed with load.

8. The dynamo should be light. The reasons are obvious, but it is considered last, because usually a careful study of the materials, and arrangement of the plant, can accomplish more towards reducing the total weight than the strict adherence to a specification of watts per pound of dynamo. Thus, consider the defference between the weight of a 40 horse-power ship plant on a five watts per pound specification and upon a four watts specification. Two 200 ampère, 80 volt dynamos, with their share of the bed plates, will only weigh about 7,500 pounds. Twenty per cent. of this will be 1,500 pounds, an amount a large portion of which can really be saved in some cases by more careful attention to the amount of wire and molding employed.

Naturally no one dynamo can best fill all of these conditions, and while the order in which they are above arranged will usually approximate to their relative importance, special cases arise which demand a re-arrangement. Thus, on torpedo boats, the most important quality is small size. With this in view, numerous devices have been placed upon the market and faithfully tried, but none have to my knowledge proved satisfactory. The requirements of high efficiency, low speed and low heating, all give way in this class of dynamo to the necessity of compactness and light weight. Good results were hoped for from the Parsons turbo-electric generator, but experience at Newport demonstrated that the turbine was so inefficient in its consumption of steam as to place its use out of the question. There is as yet no apparatus to satisfactorily fill this want.

Up to the present all of our ship plants contain two or more similar sets, each composed of an engine and one direct driven dynamo. The larger of these are of 200 ampères capacity; a very convenient unit, but one which can be doubled in capacity with advantage in ships which are not light below decks, and which are likely to soon have extensive motor application; for example, vessels of the monitor type.

The voltage in use in the navy is 80 volts, this having been fixed upon as a mean between the most efficient pressure for the incandescent system and the voltage necessary for the search lights, to which current is supplied by the regular service machines. The incandescent lamps have given excellent results as to life from the very start, owing in great measure to the fact that low efficiency lamps are always used, nothing more economical than 4 watts per candle-power being usually required.

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* A paper read before the American Institute of Electrical Engineers, Boston, May 20th, 1890.

Search lights of 50 volts and from 50 ampères up are used, two or more being supplied, according to the size of the ship. Some of these are imported, others are made in this country.

The two wire system has always been used in the naval service, the ship never being allowed to form the return circuit. On account of the present beginning of motor work on board ship, and the future developments confidently looked for, the direct current has always been used. Motors have thus far been used only in driving small fans up to one-half horse-power, for hoists, and in one case a motor has been used for training one of the large guns—on the *Chicago*. There are numerous small engines about a man-of-war, varying from 1 to 50 H.P. Some of the smaller ones might even now be replaced with advantage by electric motors, but it must be proved in each case that the motor not only does the duty as well as the engine it replaces, but also that it and any increase necessary in the generating plant take up less room and weigh less than the engine and its piping. This, of course, will always be the case where very small engines are replaced, and as the tendency is to increase the capacity of the dynamo plant, it may not be long before motors may look for a larger field on board ship.

All circuits are water tight from dynamo to point of distribution, the cut-outs having stuffing boxes through which the lead covered wires enter. Even the switches and attachment plugs for portables are required, in certain places, to be water-tight.

One electrical application that presents many advantages on board a man-of-man, especially when on a foreign station, is electrical welding. However, when it is introduced on ship board, the pressure of the generator should be reduced to 80 volts, in order that in case of emergency it might be used for lighting purposes, while the welders should have several sets of adjustable clamps. Welding machines have not yet been actually used on ship board, but it is to be hoped that their introduction is a development of the near future. They cannot supplant any of the existing dynamos, owing to the necessity of motors, but must come in to occupy a place of their own, to almost entirely supplant the ship's forge and add to the general useful equipment.

Thus the man-of-war is the proper field for nearly every form of application of electricity, and when the storage battery becomes more suited to the service there required, there is no doubt that it too will come in for its proper share of usefulness.

As to the naval work on shore in the electrical field, little need be said, as the practice at naval stations must be similar to that in ordinary commercial work. However, a navy yard is an ideal place for the erection of a central station for light and power. The streets must be lighted; closely grouped about the station are offices and large shops needing light in the dark afternoons, and power for motor work; then in an outer approximate semicircle lie the officers' quarters; finally, there are anchor chains to be welded, boiler tubes to be repaired, and numerous other similar operations which can be better accomplished by the welder than by any other known means. This, in an ideal plant, will call for arc lights, incandescent lights, constant potential motors, a welding generator and welders. The complete combination will probably not be realised at any one place within several years, but a good beginning has been made in the arc light plant recently installed for outside and shop lighting at the Washington Navy Yard, and the progressive plan adopted by the department leads us to hope that the shore stations will rapidly receive the benefits already enjoyed on ship board. Owing to the usually close grouping of the buildings, and to the demand for motors, it is probable that only in exceptional cases will the alternating current be used extensively. Good use is already being made of small motors for drilling purposes at the New York Navy Yard, where several are in constant operation, having driven out the portable steam engine, countershafting and belting.

The applications of electricity in the navy have always been on the increase, and anyone who has served one cruise with oil lamps and one with electric lights and motors, will understand the favour in which the increasing use of electricity is held by the naval man.

NOTES.

Electric Lighting at Fareham. — The Fareham Electric Light Company having entered into a contract with the Local Board to light the town by electricity for the space of three years, are pushing forward their arrangements with the view of having their installation ready before winter. An eligible site has been obtained for a central station, and a building erected thereon from the plans of the secretary (Mr. Arthur Blake), which will afford every necessary accommodation. Two dynamos will be used in the engine-room—one for arc and the other for incandescent lighting, and the motive power will be supplied by one of Ransome and Sims's 80 H.P. engines.

Wimbledon and the Electric Lighting.—At a public meeting held last week a resolution was passed by a large majority against the scheme of the Local Board.

Electric Lighting in Spain.—Acting-Consul Witty, of Barcelona, reports that the city has been partially illuminated by electricity for some years past; but the Spanish company that monopolised the work fell into financial difficulties during last year, and had to seek the aid of some experienced capitalists and electricians. The company has been re-formed, an entirely new board of directors constituted, and with the addition of a considerable amount of British capital and energy, it is hoped that it may now do good work in Barcelona.

A Really Great Invention.—We read that a Boston man has invented a lever apparatus, by means of which the keyboard of a piano may be disconnected from the strings and become mute, although the original touch is still maintained. Here, says a contemporary, lies the value of the invention; but we should say that the touch matters not in the majority of households so long as no sound is to be heard. There is but little doubt that the new-fangled piano, which has an electric bell attachment for use whenever required, will prove of inestimable value in every household where *music* is cultivated, for what has hitherto been to the majority of listeners a painful ordeal can in the future be borne with equanimity. Moreover, conversation, which at fashionable gatherings is so frequently curtailed by music, can now be carried on uninterruptedly.

City of London and Southwark Subway Bill.—A Select Committee of the House of Lords, on Tuesday, presided over by Lord Belper, passed the Bill, which has already been sanctioned by the House of Commons, authorising the City of London and Southwark Subway Company to extend their line, now in course of completion, from its present terminus at Stockwell to Clapham Common. The clause for the protection of the National Telephone Company is retained. For the purpose of carrying out this extension of seven furlongs, nine chains, the company are empowered to raise £200,000 additional capital, and to borrow in respect of that capital the sum of £50,000. The name of the company is changed by the Bill into the "City and South of London Railway Company," and an extension of time is granted within which to complete the construction of the original line.

Smoke Annihilated.—Mr. Samuel Elliott, of Newbury, claims to have devised an apparatus by the adoption of which the smoke nuisance will cease to exist. The process removes from the products of combustion all the black carbonaceous matter of coal smoke, and a remarkable and important thing is the entire absence of sulphur in any form after the dense volumes of smoke generally seen issuing from chimney shafts have been forced into the "annihilator." We hope to give in our next issue further particulars of an invention for which such wonderful results are claimed.

The Institution of Electrical Engineers.—Meetings will be held in Edinburgh on the 15th, 16th and 17th of July, when papers will be read by members. The rule which forbids the reporting of the proceedings will on this occasion be relaxed. We understand that the President, being desirous of rendering the Annual Conversazione especially attractive, hoped to be able to hold it in a new *locale*. Every preparation had been made in anticipation of that arrangement, which has however fallen through, and it being now too late in the season to make any other, the *soirée* will be postponed until after the recess.

The Telegraph Conference.—A luncheon was given on Tuesday at the Hôtel Continental in honour of the Minister of Commerce by the Delegates of the Telegraphic Companies who are taking part in the Conference here. Sir John Pender, chairman of the Eastern Extension Telegraph Company, presided. There were nearly 200 present, and they included the Marquess and Marchioness of Tweddale, Sir James Anderson, Sir E. Blount, the Comte de Lesseps, Sir F. D. Bell, Agent-General for New Zealand, Colonel Mallock, Tigrane Pacha, Mr. Condie Stephen, of the British Embassy, and Mr. J. C. Lamb. In proposing the health of the Minister of Commerce, Sir John Pender spoke in terms of warm appreciation of the courtesy shown by M. Jules Roche to the members of the Conference. He then dwelt upon the important work now being done by the Telegraph Companies in bringing all parts of the world into closer communication. Even the Dark Continent of Africa, he remarked, had at length been brought into hourly communication with the most distant parts of the earth. The extension of telegraphy was a mission of peace, fostering the friendship and goodwill of nations. It would seem, he said, that Providence had created this great power to meet the requirements of humanity. M. Jules Roche replied. Sir John Pender also gave the toasts of President Carnot, the Queen, other crowned heads, and Presidents of Republics, all of which were drunk with enthusiasm.

New Signal Station and Cable.—In a letter written to the *Standard* in September, 1886, Sir E. Watkin pointed out the pressing necessity which existed for connecting Tory Island with the mainland of Ireland by means of a telegraph cable. We are glad to see that the matter has now been taken seriously in hand by the Committee of Lloyd's. A bill was passed some time ago, under the provisions of which Lloyd's have been able to acquire the land requisite for the establishment of a signal station on the island. The necessary cable has been manufactured and will shortly be laid by the Silvertown Telegraph Company, who, we understand, have also undertaken the maintenance of this line.

Gutta-Percha.—In the annual account of produce, exports, and imports from Sarawak, we learn that in the year 1889 the quantity and value of gutta-percha exported exceeded the quantity and value exported in any year since 1882. The figures for 1888 show a weight of 201,200 pounds, value £15,490 12s. 3d., giving an average price of 1s. 6½d. per lb., while during the year 1889 the total amount exported was 266,133 lbs., valued at £35,637 6s. 3d., or an average of 2s. 8¼d. per lb. The India-rubber exported in 1889 was valued at £9,610 2s., as against £10,485 7s. 9d. in 1888.

J. E. H. Andrew and Company.—The makers of the Stockport gas engine have submitted to our notice a gratifying testimonial from Sir W. C. Leng & Co., of the Sheffield *Daily Telegraph*, who have had put down in their machine-room a pair of 14 H.P., nominal, double-acting gas engines of this make. The engines afford power for running five web printing machines at full speed, the double-acting ends of the engines enabling them to run 6, 12, 18 or 24 horse-power, according to the demand upon them. The testimonial also says that the engines run smoothly, are practically noiseless, and the exhaust being broken into four different and distinct explosions is almost imperceptible.

Cable Laying.—The first Imperial mail steamer to Zanzibar will sail from Hamburg on the 23rd inst. The laying of the cable from Zanzibar to Bagamoyo and Dar-es-Salaam will be completed shortly, and there will then be direct telegraphic connection between Germany and her East-African possessions.

Woodhouse & Rawson.—Messrs. Woodhouse and Rawson, United, Limited, have received a First Award of Merit for their show of electrical apparatus at the Exhibition at Dunedin, New Zealand.

Mix & Genest.—The well-known Berlin firm of Messrs. Mix and Genest having recently determined upon taking steps with the view of further developing their business in this country, are fitting up a branch-establishment and show-rooms at 34, Aldermanbury, where in future stock will be kept of the large variety of electrical goods that are turned out at their manufactories. They have also fitted up works at Bow, with modern and improved appliances to enable them to meet all requirements of an urgent character without communicating with Berlin. The London business is conducted in the name of the International Electric Company. A preliminary price-list is now ready, to be followed by a new and complete catalogue shortly.

Ewen & Co.—Messrs. Ewen & Co., of 37, Walbrook, who act as London agents for Messrs. Charlesworth and Hall, of Oldham, also give attention to the requirements of electrical engineers in the matter of boilers for central station and other installations.

Automatic Electrical Call Box.—The following letter has arrived too late for our correspondence columns:—"The prominent notices of an 'automatic electrical call box' and a 'peace-making binding post,' given in your issue of last week, would lead the uninitiated to believe that these improvements are now made for the first time. Allow us to say that we have for some time past been using a 'terminal' or 'binding post,' with a head so made as to defy a friendly removal; and with regard to the automatic call box, we are sure that when the patents do expire, it will be found that very many such instruments will be brought forward. Their name is legion. We believe that we are correct in saying that at the present time nearly every large town in England, and also in Scotland, has call boxes working satisfactorily. We would be pleased to submit to you, or to any enquirer, a patented one of our own, which we consider answers all the purposes, found by experience to be needful in a telephonic system.—CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED."

Winding Up a Liverpool Company.—In the Chancery Division, this week, a petition was heard for an order for a compulsory winding up of the Automatic Electric Railway Signal Company, Limited, whose registered office is at Liverpool. The petitioners were Blakey, Emmott & Co., whose claims amounted to £1,000. The company has already gone into voluntary liquidation, but, after hearing counsel, his lordship ordered that the winding up be continued under the supervision of the court.

Underground Conduits.—The system adopted by the Brooklyn (U.S.) Company, of connecting their underground conduits with ventilating shafts, and thus allowing a free current to pass through the system, has continued to work well, and free the pipes from gas. We learn now that Chicago has "caught on," and that the City Surveyor has had a connection made between the electric lighting conduit system and the chimney of the works, the result being that the conduits are now kept free from gas, and explosions, which at one time were very frequent, no longer occur. This remedy, as we have previously pointed out, is extremely simple, and deserving of attention in this country.

Cable for West Coast of South America.—We learn that the Silvertown Telegraph Company is manufacturing about 1,750 miles of cable for the Central and South American Telegraph Company. This cable will be laid on the West Coast of South America, connecting Valparaiso direct with Iquique, and Iquique with Lima.

Telephone Communications with Anchored Vessels.—Experiments are to be made at Havre of telephoning between vessels at anchor and the town. As soon as a vessel arrives in the roads it will be connected to the municipal telephone lines. In this way the captain and passengers can immediately enter into communication with the merchants of Havre and even of Paris.

Electrical Section London Chamber of Commerce.—A meeting of the electrical trades section of the London Chamber of Commerce was held on Monday at the offices, Botolph House, Eastcheap, Mr. R. E. Crompton in the chair. The committee recommended the reappointment of Mr. Trotter as correspondent, providing the Council continue to supply half of the salary, and that the remainder of the salary be obtained by subscription among the members. The question of overhead wires was discussed, *apropos* of the regulations prescribed by the Board of Trade under the provisions of the Electric Lighting Act, 1888, "for the protection of the public safety and of the electric lines and works of the Postmaster-General, and of other electric lines and works." Special reference was made, and objection taken, to Clauses 9 and 12 of the regulations, relating to the insulation, &c., of cables and the suspension of conductors; and the chairman expressed his belief that if the requirements of the Board of Trade were enforced they would prove practically prohibitory of the work in the future. The question was therefore of universal and supreme importance to the trade. Eventually, on the motion of Major Flood-Page, seconded by Mr. R. S. Erskine, the following resolution was passed:—"That this meeting of the electrical trades section of the London Chamber of Commerce, feeling that if the Board of Trade insist upon their decision with regard to cables, as announced in their letter of the 30th ult. to Messrs. Crompton and Co., it will be detrimental to the interests of the electrical trade without providing additional protection to the public, earnestly solicits the Board of Trade to give their favourable reconsideration to Articles 9 and 12 of the rules and regulations for overhead wires, with a view to their decision being modified." We have been asked to call attention to the proposed electric launch water party on July 5th. Official circulars so often get thrown on one side that we are pleased to accede to the request. It is rumoured that although the price of tickets does not include wine, it does not follow that thirsty souls will be under the necessity of landing to get drinks, as energy will be stored otherwise than in accumulators, and will be available, at various efficiencies, in units of the bottle. The catering will be done by the Army and Navy Stores, a sufficient guarantee that it will be well done. Gentlemen desirous of "squirming," "ohming," or "volting" up the Thames should make application for tickets at once.

Morgan's Electric Police Signal System.—A practical demonstration of this system, which was described in our issue of the 7th March last, is about to be made in the south-west of London; permission has already been obtained for the erection of thirteen signal lamp-posts, which will be connected by underground wires with the central depôt at one of the police stations. The apparatus is being made in Newhaven, and will shortly be received in London, when operations will at once begin.

Fatal Electric Wire Accident.—The daily papers record another fatal electric wire accident at Norristown, Pennsylvania, last week. A man accidentally trod upon an electric light wire, which had been blown down by a storm, and was instantly killed.

The Telegraph Congress.—The correspondent of the *Morning Post* hears that the International Telegraph Congress has decided that the following reductions should be made in the telegraph tariffs between Great Britain and the following countries:—Austria-Hungary, from 4½d. to 3d.; Switzerland, 3½d. to 3d.; Denmark and Norway, 4d. to 3½d.; Sweden, 5d. to 4d.; Spain 4½d. to 4d.; Portugal, 5½d. to 4½d.; Russia 6½d. to 5½d. Between Great Britain and Germany, Belgium, Holland, and France no change in the tariff has been resolved on.

Practical Electrical Engineering.—This monthly work seems to be in labour. A notice attached to the last issue says:—"The present number, instead of being part III., vol. I., is part X., and forms the first part of vol. II." We have already referred to the illustrations in the first number as being quite unconnected with the text, so if part IV. turns out to be part XI. readers will get hopelessly mixed. A friend says this method of publication is illogical, but perhaps he is hypercritical.

Telephonic Progress in the West.—The number of subscribers to the telephone exchange, established by the Western Counties and South Wales Telephone Company, in Plymouth, Devonport and Stonehouse, now amounts to 290, an increase of 13 since January last. With the object of increasing their trunk line business the company have reduced their toll charges for messages to Torquay, Newton, Dartmouth and Brixham, from 9d. to 6d. per three minutes. The trunk service between Mutley and Plymouth has been duplicated, and the same course has been taken with regard to the lines between Plymouth and Devonport. The Royal Albert Hospital, at Stonehouse, has also been connected with the system free of charge.

The Institution of Civil Engineers.—The following awards have been made for communications submitted during the past session:—The Manby Premium to William Paul James Fawcus, and to Edward Woodrowe Cowan, Assoc. MM. Inst. C.E., for their joint paper descriptive of "The Keswick Water-power Electric Light Station;" the Miller Scholarship to Charles Frewen Jenkin, B.A., Stud. Inst. C.E., for his paper on "Some Applications of Electricity in Engineering Workshops;" a Miller prize to Charles Henry Wordingham, A.K.C., Stud. Inst. C.E., for his paper on "Telephonic Switching."

Contracts with Foreigners.—A parliamentary paper has been published giving a return of all contracts for articles of home manufacture between the 1st day of April, 1889, and the 31st day of March, 1890, with contractors outside the kingdom. The contracts entered into thus by the Admiralty were for carbons for electric light, £228; Mangin mirrors for electric light projectors, £11,236—total, £11,464. The only other department which entered into such contracts was the Post Office, which in this manner spent £1,016 on Hughes's telegraph instruments.

Conversazione.—A *conversazione* was given on Wednesday night, in the rooms of the Royal Society, by the President, Sir G. G. Stokes, Bart., M.P., L.L.D. Many interesting exhibits, lent by various members of the Society, were to be seen, and a lecture by Dr. Fleming excited great interest.

A Distinction and a Difference.—The New York *Electrical World* says :—Some few weeks ago we published a report from Mr. Mordey stating that the great alternating central station at Deptford disturbed the telephones in Paris. The statement seemed a marvellous one, hardly credible in view of previous experience in this country ; but as it was given on the authority of one so well versed in such matters as Mr. W. H. Preece, a request was sent to that gentleman to give the facts in the case for the benefit of the electrical fraternity here. He has kindly responded, and states that Mr. Mordey somewhat misunderstood the action that really took place. The cables from the Deptford central station, carrying at the present time alternating current at a potential of 3,700 volts, pass quite near the London telegraph system, more especially the circuit from London to Rome *viâ* Paris. The telegraph service was frequently greatly disturbed, currents of as much as 18 milliampères having been detected on the lines, and the London-Rome circuit was rendered almost useless. A telephone placed in this circuit at Paris gave ready evidence of the alternations at Deptford. The Paris telephone system, it will be seen, was not disturbed, although a telephone inserted in the line in question as a test instrument gave clear evidence of the interference. The amazing statement made by Mr. Mordey is therefore not borne out by the facts, although the trouble from the alternating current was and is very great.

Telephonic Inter-communication between Towns.—The District Manager, at Manchester, of the National Telephone Company has favoured us with an advanced proof of a new map, showing the telephonic connections between the chief centres of industry in the North of England. Within the next few months it is hoped to have all these towns connected with the City of London and with the chief places in the south of England.

The Telephone.—It will be remembered that at the opening of the Telegraphic Conference now being held in Paris M. Roche, Minister of Commerce, claimed for M. Charles Bourseul, a Frenchman, formerly employed as a clerk in the Adminstration of the Posts and Telegraphs, the honour of having formulated the principle of the telephone 20 years before its invention. M. Bourseul retired from the public service in 1886, and has since then been living at Cahors. Summoned to Paris by M. Jules Roche, M. Bourseul has just been entrusted by the Minister with the task of seeking what improvements can be made in the telephone as it exists at present.

Personal.—The partnership which existed but one year between Messrs. Paget & Kintner, electrical experts and patent agents, of New York, has been dissolved, and Mr. Kintner will continue to carry on the business in his own name. The last-named gentleman was well known to our readers shortly after the ELECTRICAL REVIEW assumed its weekly form.

NEW COMPANIES REGISTERED.

Kent Patent Arc Lamp Company, Limited.—Capital £10,000, in £5 shares. Objects : To acquire certain inventions in connection with electric lighting, upon terms of an unregistered agreement between John Kent and Arthur Salter. Signatories (with one share each) : H. Steinberg, 45, High-street, S.E. ; A. Salter, 9 and 10, Railway Approach, S.E. ; R. Dyson, 15, Australian Avenue ; C. Willson, 6, Upper Woburn Place ; J. G. Cornwall, 21, Portland Place, Clapham Road ; W. Ironside, 1, Gresham Buildings ; H. P. Gyles, 9, Warwick Road, Anerley. The signatories will appoint the first directors ; qualification, £100 in shares or stock. Registered 13th inst. by Leslie, Antill and Arnold, 1, Gresham Buildings. Registered office, 9 and 10, Railway Approach, London Bridge.

Baxters, Limited.—Capital £30,000, in £5 shares. Objects : To carry on business as general, mechanical, manufacturing, civil, marine and electrical engineers. Signatories (with one share) : *F. U. Baxter, 53, Highbury Park ; Mrs. F. U. Baxter ; *A. W. Baxter, Nottingham ; Miss J. G. Baxter ; and *C. H. Baxter, Sandiacre, Nottingham ; G. Franklin, Sheffield ; A. H. Atkins, 23, Bouverie Street. The signatories denoted by an asterisk and Mr. S. B. Baxter are the first directors. Qualification, two shares. Registered 16th inst. by A. H. Atkins, 23, Bouverie Street. Registered office, Sandiacre, Derby.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Durand Electric, Petroleum and Gas Engine Company, Limited.—An agreement of 11th March, filed on the 5th inst., relates to the purchase by the company from Wm. Forsyth Black, of 4, King William Street, E.C., a certain patent right, and also the business carried on by Monsieur Eugene Durand at 168, Avenue Victor Hugo, Paris. The consideration for property in the United Kingdom is £100 in cash or fully paid shares, and for the property out of the United Kingdom, £89,900, payable as to £15,000 in cash, shares, or debentures ; and as to £74,900, in fully paid shares. Registered office, 175, Strand.

Sunbeam Lamp Company, Limited.—The annual return of this company, made up to the 13th March, was filed on March 25th. The nominal capital is £25,000, in £10 shares ; 2,204 shares are taken up, and the full amount has been called thereon, 2,000 shares being considered fully paid. The calls paid amount to £1,535, and unpaid to £505.

India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.—The annual return of this company, made up to the 28th February, was filed on the 23rd April. The nominal capital is £812,000, in £10 shares. 41,600 shares are taken up, and the full amount has been called thereon, the calls paid amounting to £416,000.

Brighton Electric Light Company, Limited.—The annual return, made up to the 9th inst., was filed on the 12th inst. The nominal capital is £100,000, in £5 shares. 3,000 shares are taken up, upon 1,400 of which the full amount has been called, and upon 1,600 the sum of £1 5s. per share has been called. 1,600 shares are considered as paid up to the extent of £6,000. The calls paid amount to £9,000.

Telpherage Company, Limited.—At an extraordinary general meeting of the members of this company, held at Winchester House on the 23rd ult., it was resolved to wind up voluntarily. The resolution was confirmed on the 10th inst., and duly filed on the 12th inst.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended June 13th, amounted to £4,571.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 13th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,543.

West India and Panama Telegraph Company, Limited. The estimated traffic receip for the half month ended the 15th June, are £3,258, as compared w £3,134 in the corresponding period of 1889.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 12).	Closing Quotation. (June 19.)	Business done during week ending June 19, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	99 —102	100⅜	...
1,549,160	Anglo-American Telegraph, Limited	Stock	50½— 51½	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	87 — 88	86½— 87½	87¾	86¾
2,725,420	Do. do. Deferred	Stock	15½— 16	14¾— 15¼	$15\frac{7}{16}$	15¼
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	$12\frac{3}{16}$	12
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	106 —109	106 —109		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2⅝— 2⅞	2⅜— 2⅝	2⅝	2⅜
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅞— 2⅛	1¾— 2		
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	½— ¾	½— ¾		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5¾	5¼— 5¾		
16,900	Cuba Telegraph, Limited	10	11¾— 12¼	12 — 12½	12½	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17 — 18	17½	17
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9⅝	9¼
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	$10\frac{5}{16}$	10¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅞— 14⅛	14 — 14¼	$14\frac{3}{16}$	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½		
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 —111	108 —111	109	108¾
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	105 —108	106½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13⅞— 14⅛	14⅛— 14⅜	14¼	14⅛
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103	103½	101½
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	104 —107		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106	103	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 —105	102 —105	104½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4¾— 5¼	5½— 6	6	5⅛
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2¾	2¼— 2¾		
180,227	Globe Telegraph and Trust, Limited	10	8⅞— 9⅛	8⅞— 9⅛	$9\frac{1}{16}$	8⅞
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼	15¾— 16¼	16¼	...
40,900	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	19½— 20½	19 — 20	20¼	19⅝
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5¼— 5¾	5¼— 5¾		
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5¾— 6	5¾— 6	6	$5\frac{13}{16}$
49,825	Do. New Nos. 386,876 to 436,700	5	5½— 6	5½— 6	5½	...
15,000	Do. 6 p. c. Cum. 1st Preference	10	12½— 13	12½— 13	12⅞	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10¼— 10¾	10¼— 10¾	10⅝	10⅜
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7¾— 8¼	7¾— 8¼		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3¼— 3¾	3¼— 3¾		
3,381	Submarine Cables Trust	Cert.	112 —116	112 —116	114½	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5¼— 5¾	5¼— 5¾	5¾	5½
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45	44½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 — 104	101 —104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9½— 10½		
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	100½	99
30,000	West Coast of America Telegraph, Limited	10	6½— 7	6½— 7	7	$6\frac{13}{16}$
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	111 —116	111 —116	113½	112⅛
64,572	Western and Brazilian Telegraph, Limited	15	9¾— 10¼	10 — 10½	$10\frac{1}{16}$	10
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6¾	6¼— 6¾	6¾	...
26,986	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3½— 4	3⅞	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109	107	...
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝	2⅞	$2\frac{7}{16}$
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½	11½	11⅛
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	12½— 13½	12½— 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¾— 2¼	1¾— 2¼		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Electric Construction Corporation (£10 paid), 9¾—10¼.—House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅝—2⅞.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

SINGLE AND DOUBLE TROLLEY WIRE SYSTEMS FOR ELECTRIC RAILWAYS.*

ON Monday evening, April 28th, Mr. George W. Mansfield, engineer of the railway department of the Thomson-Houston Electric Company, read a paper on the above subject, which we print herewith in full :—

In addressing you this evening on the subject of "Single and Double Trolley Wire Sytems for Electric Railways," I shall endeavour to precisely place before you the advantages and disadvantages of each system. The other day while studying over the subject, the following questions arose in my mind :—Why should I spend any time whatever in discussing the two systems? Is it necessary? If so, why? I think my telephone friends here could answer that question perhaps.

I read Mr. Denver's paper with mingled pain and pleasure—pain on account of his sufferings, and yet pleased to learn, clear at the end of the paper, that he had a remedy. The antagonism of the telephone companies to the single wire system has become universal and their love for the double wire system proverbial. This opposition has provoked much discussion and led to deep thought. My own thinking and experience has forced me to the solid conviction that for an efficient electric railway system which can be universally used, the single trolley wire is the only one to be considered. Being, then, of this conviction, the time I spend upon the double trolley wire system is purely educational for my dear friends in the telephone companies, and I trust I merit their hearty applause, since they all tell me they want electric railways and the best.

The principles involved in the construction of a single trolley wire system are familiar to you all. You know that it can be done successfully and is done successfully. Do you or does anyone know that under all the conditions under which the single trolley wire works successfully, the double trolley system will also work successfully?

If the difficulties with the single system have all been overcome and those of the double system have not, let us consider what we must take into account to make the latter equal the former.

With the double system the weight of the second wire, the insulators, frogs, crossovers, &c., the double liability of sleet and ice accumulating on the two wires, and the high winds, all necessitate larger and stronger poles and stronger span, pull-off and anchor wires, &c. This increase in size and number of wires means additional unsightliness, a larger original outlay and an increased expense for maintenance.

One of the chief tronbles which an electric railway has to contend with is to keep its trolley wire free from snow and ice during the winter months. Prompt and energetic action, with a greased trolley wire has saved the single trolley roads from any serious delay. If these same roads had had two wires to clean, I have no question but that their service would have been seriously impaired, if not entirely stopped.

I do not think that the question of traction is one of any serious moment. The rails must be cleaned for adhesion and for the cars to keep on the track irrespective of whether the single or double trolley wire system is used, and as they are get-at-able they are comparatively easily taken care of. It is simply a question of management, muscle and salt and with improved electric sweepers and ploughs, there never need be any great difficulty in keeping the cars running on schedule time. The problem, however, of cleaning sleet frozen to a trolley wire placed 18 feet above ground in a large city or even on a country road is a most annoying and troublesome one.

One, it not the greatest difficulty, which would have to be overcome with the double trolley system, is the liability to leakage. The two wires hanging side by side upon the same span wire need the best of insulators. Considering all the atmospheric conditions and the possible accumulations of sleet and snow, it unquestionably would be more difficult to maintain good insulation between the two wires than it is between the single wires and the ground. With the latter system you have far greater opportunities to introduce additional insulation. It can be cut into the span wire or placed on the pole, whether it be of iron or wood.

So far the under-running double wire roads have had the wires placed either 6 inches or 18 inches apart. The Daft roads employ the former distance, while the Thomson-Houston Company in its attempt at Cincinnati used the latter distance. Both methods have their objections. If the wires are placed too near, strong winds may swing them together, causing short circuits. In one place the short circuit,was so heavy that the wires were melted and fell into the street. With the wires farther apart, plainly this trouble would not exist. With the wires close together a single trolley arm can be used, but a double trolley fork and two wheels are necessary. These wheels must be thoroughly insulated whether they rotate upon a separate or upon the same spindle. The maintenance of an insulation sufficient to withstand 500 volts under such conditions is surely not an easy task.

With the wires further apart the necessity of more than one frog at the crossings and turnouts is necessary, which is objectionable, and more than one trolley arm would have to be used. The maintenance of these trolley arms, the difficulty of keeping them on the wires, and their weight upon the roof of the cars are all serious objections. In the single wire system, questions of weight, insulation of trolley wheels, &c., practically do not enter.

Another serious objection to the double system is in the overhead switching. The placing of overhead frogs even on the single wire system requires the greatest exactitude and care, so much so that on many roads it has been found necessary to train a special gang of men to place and look after their adjustment. The expansion and contraction of the wires and the giving and taking of the poles are constant sources of annoyance and trouble in keeping the frogs and insulators in place. The expansion of copper is $\frac{1}{8}$th inch per degree for 1,000 feet, or $\frac{5}{8}$ths of an inch per mile for each degree of change in temperature. If the temperature changes, as it often does, twenty or thirty degrees in a day, the trolley wire might expand or contract 15 or 20 inches per mile. With the double trolley wire system the location and maintenance of the frogs on the cross-overs and turn-outs would, in view of these circumstances, be an extremely difficult one. They would require constant adjustment and re-adjustment, and if the method of placing the trolley wires 18 inches or more apart was employed, so that a large number of frogs was introduced, it would practically be a determining factor between the possible and the impossible system.

On complicated systems of double track lines, the number of insulators and frogs for the double wire system would be very large. I have frequently studied such systems and have found that it is by no means a rare occurrence to meet arrangements of tracks that require from 25 to 50 overhead frogs and insulators, and in some instances from 125 to 150. The weight of all these necessarily demands a most substantial overhead construction, and undoubtedly the only thing that could be done would be to erect large and substantial trusses. It must be also evident that the difficulty of keeping the trolley wheel upon these wires is largely increased and also the liability of some of the ends breaking loose from a frog and falling.

Imagine such a network of wires loaded with ice on a winter's morning. Add to these wires, if you will, the necessary guard wires, and it is as essential to put up guard wires with the double system as for the single, and I for one would not have sufficient audacity to argue for the same before a city council. It can also be clearly shown that the wires of the same polarity of the double system will not in all conditions correspond when they are attached to the frog. To illustrate what I mean, take the single track, Y. If a sketch of this is made on the double wire system, it will be seen that if the right hand wire is a positive wire, and the left hand wire a negative wire on a straight piece of track, and they are carried around the Y on to a branching track, the positive and negative leads are bound to conflict. Under such circumstances either the current must be broken on the motor when the car passes that point, or there will be bad flashing in the switch.

It is practically impossible to construct a frog for such a place that will permit the trolley wheels to roll across, taking current from the same continuously. There will have to be a break in the continuity of the circuit at the frog for a certain length of time. This break means the going out of the lights every time the car passes such a frog. With the single wire system, none of these difficulties are experienced. On large roads the cost of copper necessary for the double wire system would be so great as to be almost prohibitory. With the single trolley system, the earth being used as a return circuit, we obtain the aid of its conductivity and also that of the rails. Practice has demonstrated that with such an enormous conductive area the resistance of the return circuit can practically be considered *nil*. It is true that the supplementary wire of a size equal to the trolley wire is run through the earth and connected to each rail. The use of this conductor is twofold. It not only forms a good ground for each rail but it ties the whole underground system into one connected and complete metallic system. Counting the resistance of the earth as 0 it is readily seen that only one quarter of the copper wire is necessary for the single system as for the double wire system. Hence a most decided saving is possible.

On a large system the subject of feeders always is a most important one. With the single trolley system it is only necessary to feed one-half of the circuit, whereas with the double trolley system it is necessary to feed both sides of the circuit. In this direction alone, therefore, the cost of the latter system must be four times that of the former, allowing for the same percentage of loss.

In regard to guard wires, I see no reason why it is not practically as necessary to place them over a double wire system as over a single. With the current passing out over one wire down through the car, through the motors under the car and back by the other wire, the chances of leakage are very great.

It would be very difficult to prevent leakages somewhere on such circuit. If a leakage should be established on the positive side of a motor armature on one car and on the negative of another, both of the cars and station might be damaged. If these leakages are so liable, the danger from a foreign wire falling across either one of the trolley wires still exists. It is unfortunate, but nevertheless true, that arc light wires which are supposed to be thoroughly insulated from the ground leak at times sufficiently to cause damage to life and property if a telephone or telegraph wire happens to fall across them. With bare trolley wires and with the increased chances of leakage, surely the city authorities would not and ought not to permit the erection of the double trolley system without the same system of guard wires over them as is placed over the single trolley system. The expense incumbent upon the railway company in this direction therefore is equal for both systems. The danger to property in my opinion is practically equal in both systems.

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* *Modern Light and Heat.*

I do not deny the fact that it is possible to so construct a simple double trolley system that a falling wire touching one of the trolley wires and with its other end on the ground, would deflect no current, nor would I deny that under similar conditions a man touching this fallen wire and standing upon the ground, would receive no shock. This is speculation, not fact, and I am not arguing this matter from a theoretical or a possible condition of affairs, but from the results of practice which teach that ordinary existing circumstances always militate against the ideal, giving as a resultant, a system materially different from what we supposed it would be.

Repeating, therefore, what I have said in regard to danger to life and property, I feel that the danger question is practically equal in both systems.

It is unnecessary for me to state to you the fact that 500 volts is not dangerous to life, since I think there is no question but what you all have taken such a potential if not higher, and I should be pleased to have any of you state, if a dicussion follows this paper, whether you have taken this potential or a higher one, and the circumstances.

As to the relative expense of the two systems, leaving out the question of feeder wires, it is true that practically in every case the double trolley system wonld cost one-half as much more, if not twice as much, as the single trolley system. It may be here stated that the expense of running the supplementary wire underground is sometimes heavy. True, it is, but the expense is largely dependent upon the street through which your track passes. If it is macadamised or paved with Belgium blocks, or with any paving stones, the expense of the removal and replacement of the same would be large. Such conditions of streets, however, exist only in large cities, and here, I believe, it is generally conceded by friends and opponents that the double trolley system is entirely out of the question. The expense, however, would nowhere nearly equal the additional expense of the feeder wires for the double system, nor would it equal the cost of the maintenance of such a system for a year or two.

If, on the other hand, I admit that it is possible, but not the best system for a small road, we are happily confronted by the fact that so far in the majority of the cases, the small roads are not where it is needed, since the telephone companies, which practically represent the only opposition to the introduction of the electric railway, have not so extensive lines in these places. It is therefore the unfortunate middle man that has to suffer. In answer to all the foregoing objections to the double trolley wire system, the statement is sometimes made that there are to-day double trolley roads operating commercially successful; and that if they can operate in one place there is no reason why they cannot be made to operate in all other places. Steam dummies are used to-day in some places; why do not railroad companies use them everywhere? There is scarcely anything impossible in this practical age of ours, and therefore I do not deny that the double trolley system could not be placed anywhere that the single is placed, but I unhesitatingly state and know that it could not be placed wherever the single is placed, and prove equally as satisfactory and commercially successful. It is not a question of cost but one of expediency and practicability. The electric companies would build double systems if they could guarantee them, and the railroad companies would demand them if they had confidence in them. An unbiased thinking man is forced to adopt the single system.

History shows that the efforts of the early promoters of the electric railway were to develop a double wire system with an over-running trolley. This has proved a signal failure. The only roads so operated to-day are at Easton, Pa., Elkhart, Ind., Ithaca, N. Y., Lima, Ohio, Pittsburg, Pa., Sunbury, Pa., St. Catherines, Ont., Lancaster, Pa., Ashbury Park, N. J., Appleton, Wis., and Wheeling, W. Va., eleven in all. There are none under contract, and no firm thinks for a moment of building such a system. History also shows us that the next step in progression was the development of the under-running trolley for this same double trolley wire system. Years have gone by, and we have only three companies in the whole United States having such a system in operation, these are at Cincinnati, O., Meriden, Ct., and Mansfield, O. As illustrative of the feeling and confidence the street railway profession have in this system, I find there are but five companies who have contracted for such a system. I venture to assert at this point that if the conditions of the contracts for these roads were seen, most interesting and extraordinary clauses would be discovered.

If we now turn to the extraordinary development of the single trolley system, we find figures which truly are amazing. On July 1st, 1888, the Thomson-Houston Company was not in the electric railway business, and the total number of roads in operation in the United States and Canada, put in by all of the electric companies who then were doing business, viz., Sprague, Daft and Van Depoele, was 33. Of these but two or three were the single wire system under-running trolley; whereas to-day there are nearly 115 roads in operation, and an equal number under contract, and of these all but some four or five have been put in or contracted for by either the Thomson-Houston Company or the Sprague Company. Two hundred and thirty roads contract for the single system, five for the double. If I take the history of the Thomson-Houston Company since it commenced to build electric railways, I will find that it has in less than two years, put 61 roads in operation, and has under contract 45 more, making a grand total of 106 roads contracted for with the single trolley system, by one company. Could there be more conclusive proof of the pre-eminent adaptability to a commercial necessity than this is, for the single trolley system?

The future is destined to surpass this record as surely and as amazingly as the adoption of electric lights and telephones surpassed their records of eight or ten years ago.

LEGAL.

King, Brown and Co. v. Anglo-American Brush Electric Light Corporation, Limited.

(Continued from page 684.)

Lord McLaren: What is the criterion you propose to apply to the interpretation of the specification? Must it be so clear that a workman of ordinary skill would understand it, or would this be sufficient that this particular part of the specification would enable a person already familiar with dynamo machines as known at that time, to add compound winding to the other requisites?

Mr. Murray: I do not think honestly that there will be much between us in the law. I am quite willing to take it as already laid down on the bench. But it was difficult to make an exact definition of these sort of things. Certainly an anticipation necessary, is an anticipation which fairly discloses the invention and discloses it in a way that is understandable by a person well versed in the science.

Lord McLaren: A person who knew dynamo machines as then existing.

Mr. Murray: Certainly, and a person of great intelligence. Mr Murray quoted the case of Philpot *v.* Hanbury (2 R.P.C.) in which a definition was given by Mr. Justice Groves, to the effect that there must be publication, which, when read by persons well versed in the trade, he might even say by the higher class of skilled workmen, would enable them to understand it. He was quite willing to rest content with that; but while that was so he submitted that a very stupid person would have understood that specification of Varley, because he would have nothing to do but blindly to follow the description. Proceeding to deal with the evidence he said he wished to take the defenders' witnesses and to show how in cross-examination they had been disloged from their position. They all commenced by saying that Varley's description meant series, or shunt, or separate excitation; but he had made them to confess that the words were inconsistent with shunt, with series, or with separate excitation, and that there was nothing left but series-shunt. Mr. Murray then read from the evidence of the defenders' witnesses Silvanus Thomson, John Perry, Sir William Thomson and William Henry Preece, to prove what he had just said. Mr. Preece had, he said, gone into the box very confidently holding the view that the whole thing was inconsistent with series shunt; but when he was pressed he admitted that it was not so. He was pushed from one corner into another, and then when he was floundering, if the term might be used without rudeness, he seized upon the idea of double shunt only to abandon it. That disposed of the whole of his learned friend's scientific witnesses; and therefore he submitted that he had carried out his promise and made good his challenge to the other side that not one of their scientific witnesses when under cross-examination had stood to their guns, but that every one of them, who quite glibly said that was inconsistent with series shunt, tested by the process of elimination were driven from one stronghold after another, and forced to admit in the end compound winding, or no winding at all. He need scarcely say that, as regarded the pursuer's witnesses, their evidence was clear and distinct in the view that it was compound winding, and their testimony was unshaken in cross-examination. Mr. Murray next referred to some matters of criticism that here and there had crept up in the defenders' case. Those with which he would deal were the use of the word "divert," the use of the word "circuit," and the question of whether bifurcation—which was, of course, a necessary of any shunt or series-shunt arrangement—was in any way indicated in Varley's patent. Speaking first of the word "circuit," he said they would find witnesses saying that that term, properly used, ought to mean circuit from end to end—that nobody ought to speak of series circuit or shunt circuit, that being incorrect electrical language. That was probably true, but at the same time it did not matter, because undoubtedly in popular electrical language, and certainly in 1876, "circuit" was used in its more inaccurate sense. Probably the most conclusive reply he had to that was, that Brush himself used "circuit" in precisely the same inaccurate manner in his own specification; and Sir William Thomson, who was one of the defenders' witnesses, in his evidence, said "he thought the words used by Varley implied two circuits." I notice that Brush uses precisely the same term, because "circuit" was continually used for "branch" by writers on that subject. It was an ambiguity.

Lord Adam: The criticism is that the shunt was a branch, and not a circuit.

Mr. Murray: Yes, and that to speak of the electric light circuit and the circuit of less or of greater resistance—if you use "circuit" in its real and proper sense—was to speak of two independent things altogether, without diverging or bifurcating at all. That would be correct; but even to this day people spoke of series and shunt circuit for convenience. For example, Mr. Perry, one of the defenders' witnesses, in speaking of a series shunt machine, said that "the electricity divides itself between two circuits and two windings on the magnet." That was not really so, because there was only one circuit, for, speaking of a branch, they ought not to call it a circuit, because it was only part of a circuit. He quoted Brush's specification to show that he used the word "circuit" in precisely the same erroneous way. With regard to bifurcation, it had been suggested by some of the witnesses that bifurcation was necessary, as, of course, it was in that arrangement, and that nothing was actually said about bifurcation in Varley's patent. Sir Wm. Thomson disposed of that perfectly satisfactorily, for he said in his evidence that bifurcation of an electric current by splitting a wire was not beyond an electrical workman, and that if he found it necessary for any reason to bifurcate his current, splitting the wire would readily suggest itself. In the same way Sylvanus Thompson said in his evidence that the word "diversion" in Varley's specification was consistent with bifurcation, and that that was the language of Haddan. Coming to the question of whether separate excitation was part of Varley's patent, he said he would explain the part of the patent which enabled him to put out of the way separate excitation altogether. There were certainly two places which helped them to do that, and one of them was exceedingly strong, and utterly inconsistent with separate excitation. He quoted from Varley's specification as follows: "The number of bobbins in each group may be two or four or eight; the number of commutators employed may correspond to the number of bobbins forming the group, or they may be increased in number, and when electricity of a very high potential is desired, the commutators may be increased to the same number as the bobbins." Then, at another part, Varley said: "When the number of commutators correspond to the number of bobbins forming a group, the ends of the insulated wires of each group are joined side by side to the respective discs of the commutators." Their lordships would see that if they wanted electricity of a very high potential, they might have one commutator for each bobbin. Then Varley went on to say: "The springs which rest against the commutators are so connected as to form a continuous electrical circuit from one to the other, through the metal discs of the commutators." Their lordships would see that that was absolutely destructive of the idea of separate excitation from a separate portion of the armature, because if they had separate excitation from a separate portion of the armature, they must have that separate portion commuted by a separate commutator of its own, and, of course, taken away to the magnets, whereas the rest of the electricity developed by the armatures would be commuted by its commutator, and taken away to the circuit. If they put these two commutators in direct electrical connection, they destroyed the whole thing. Therefore, inasmuch as there was only one method of winding given, the patentee was, of course, entitled to wind any machine which had been previously described by that method of winding, and he proceeded to compound wind a machine which had a commutator of such a construction that separate excitation was impossible. In support of that contention, he quoted the evidence of Sir Wm. Thomson, Mr. Perry, Mr. Silvanus Thompson, and Mr. Preece, the defenders' witnesses, and Mr. Swinburne and Prof. Ewing, the pursuers' witnesses. Dealing with what counsel on the other side had called "electrical absurdities" in Varley's patent, Mr. Murray said Sir Wm. Thomson said that Varley had a wrong theoretical idea, which resulted, after one of the armature bobbins was cut out of a certain portion of the revolution, in throwing in the bobbin again too soon. That was exceedingly temperately put; but one of the great peculiarities of electrical science was this—that although these gentlemen had discovered a great deal in one way, they had discovered uncommonly little in another. Nobody knew, after all, what electricity was, and nobody knew exactly why it was that electricity was developed in that way out of magnetism. In fact, electrical science in one sense was entirely an empirical science. Nobody knew yet in what direction the current went, and electricians called electricity which they saw going in one direction as of a certain character, and that which went in another direction as of another character. But if they altered the nomenclature they would alter the direction. Assuming that Varley was wrong when he went a little beyond his province and described in his patent the way in which electricity was formed and magnetism was stored, it did not make any difference in his machine, except what Sir Wm. Thomson said about leading to the bobbin being thrown in too soon.

The LORD PRESIDENT: We are not trying the validity of Varley's patent, but only what it disclosed.

Mr. MURRAY: Certainly. But there was another matter to which he would ask their lordships' attention, and that was what Mr. Silvanus Thomson said, that—"Varley's machine, such as it is, works or does not work, quite irrespective of the theory on which it is constructed. The machine described in the specification is a workable dynamo machine, and at its date I do not know that there were much better." The machine which defenders' counsel wished to make out as a failure was described by their leading witness as one which, at its date, had no rival.

Lord McLAREN: He is one of the strongest witnesses against you on other points.

Mr. MURRAY: He is the leading witness. Of course the machine was a failure if they pitted it against the machines of the present time, but at its date it was a good machine, and in this question of anticipation it could not be described as a failure. With regard to the storing of magnetism in the bobbins, he should like to point out that Prof. Ewing, in his evidence, said that "so far from there being any manifest absurdity, Varley's patent showed that his knowledge and grasp of the subject were very much in advance of his time." He submitted that Prof. Ewing was probably—putting on one side Sir Wm. Thomson, whose position was quite exceptional—far in advance as an authority upon magnetism—and it was a question here of magnetism and not of electricity—of any other witness adduced in the case. But passing from that, there was a very good reason why Varley should have been anxious to introduce that compound winding. He had already admitted, as part of his argument, that Varley did not know that he was laying the foundation of constant potential, but he did know that part of his patent was concerned with a lamp, and the lamp which Varley constructed was a lamp, for the proper working of which it was almost necessary that he should hit upon compound winding. The learned counsel described the lamp which Varley's machine was made to work, and gave reasons to show that it could not have been worked either by pure series or by pure shunt, but that the difficulties experienced by either of these methods were avoided with series shunt. In support of his view he quoted the evidence of Messrs. Swinburne, Ewing, and Silvanus Thompson.

The LORD PRESIDENT: What is the bearing of all this?

Mr. MURRAY: The bearing of it is that I can show what the other side cannot show, an opportunity and an appropriate reason for having compound winding in Varley's patent. The argument for the defenders was that this could not be compound winding—that Varley did not show any reason why he should have it. He admitted that there was no reason as to constant potential, but there was a good reason in the patent why he should design compound winding.

The LORD PRESIDENT: Do you mean that a part of this lamp could not have been worked without this compound winding?

Mr. MURRAY: It comes up to that. It could not have been successfully worked without it, and Varley, in his specification, showed, by his description of the construction of the lamp, and what he said about his method of producing the electric light, that it was compound winding he was really aiming at. He would pass to another branch of the case, which his friend, Mr. Jameson, did not touch upon, but which he submitted could not be treated so cavalierly. He referred to the fact of that compound winding having been reached through Varley's specification by no less than four mechanics. The models made by these apprentices from Varley's specification varied in form, but they were all equally compound wound. He quoted the case of "Edison-Swan *v.* Holland" to show that evidence of a workman having made an instrument or machine from a particular specification was evidence of weight in the particular case. He did not say that it was conclusive, but it went a long way to show that the description in Varley's patent was not the terribly difficult thing to understand which some of the witnesses on the other side said it was. He proceeded to deal with the question of disclosure by prior use by the machine made, under Varley's directions, by Siebe and Gorman. That machine showed that it had got two windings round the magnets, and his friend could not deny that it could be perfectly easily used as a series shunt machine.

Lord McLAREN: Have you evidence that it was in fact used as a series shunt machine coupled up in that way?

Mr. MURRAY: I have got very good evidence of two sorts. It was used publicly to illustrate certain operations in a diving tank, and for the purpose of photographing an ice machine. They were not experiments on the machine itself. He quoted the authority of several cases with regard to what public use really was. In the case of "Carpenter *v.* Smith," a lock, which was the article involved in the case, was held to afford good public user, although all the public knew was that the lock was on a door, their knowledge not extending to its construction. Then, in the case of Humpherson, somebody had made a patent of a waste-water preventer which he had given to a firm to make, and that firm had made it and simply showed it in the window. It was assumed all through the judgment there, that the showing in the shop, even although nothing was done with it, was quite sufficient to be public use.

The LORD PRESIDENT: That is hardly prior use. Prior use means use by somebody else.

Mr. MURRAY: I think it is prior disclosure.

Lord McLAREN: Your point is that it is enough if the results are shown to the public, although no one can see how the thing is done.

Mr. MURRAY: Exactly so. If you put a book in a bookseller's window, that undoubtedly is good publication in the sense of the law. He went on to say that there was very good evidence to show how that machine was connected in the sketch made by Varley in an old notebook. Sir Wm. Thomson, looking at Varley's sketch, said it was series shunt. The date of the sketch was about the date of the specification.

Lord McLAREN: That is prior to Brush's patent?

Mr. MURRAY: Yes Construing Varley's specification by that sketch, he said Varley's recollection was quite correct when he said that that machine could be coupled up as shown in the sketch. There was another piece of evidence which showed quite distinctly that the machine was coupled up in series shunt. A common workman who did not know anything about these matters, and could not explain the operation of compound winding, and therefore could not have been coached, gave evidence which showed how the machine was used. He quoted from the testimony of Edward F. Myers to show that certain results which he had noticed when

Varley's machine was in operation could have been produced only by a machine coupled up in series shunt.

Lord McLaren: I think one can hardly doubt that that machine of Varley's was compound wound, although one cannot say whether it was a good one.

Mr. Murray: That is so, but it does not much matter; and the question of its being conceivably double shunt, as Mr. Preece at one time said, is put out of the way, because if it was double shunt the lamp must necessarily have had a key, and there was a joint minute put in stating that there was no key ever used with that lamp. He concluded by submitting that the patent was bad, upon the various grounds which he had adduced.

At the close of Mr. Murray's speech, the further hearing of the case was adjourned.

Tuesday, June 3rd.

The Dean of Faculty (Mr. J. B. Balfour, Q.C., M.P.) to-day addressed the Court on behalf of the defenders and reclaimers (the Anglo-American Brush Company). Dealing, in the first place, with the mechanism of the commutators, he addressed himself to the alleged disconformity between Haddan's final specification and the provisional specification, and argued that the Lord Ordinary, in giving judgment in the Outer House, had lost sight of the respective functions of a provisional and a final specification. His (counsel's) contention was that the purpose of a provisional specification was merely to mention or disclose the nature of the invention. It was in the later and final specification that the particular details and the mode of carrying out the specification were given. The object of a provisional specification was to enable a man, when he had got hold of a novel and useful idea, to work it out during the six months' protection afforded to him. In the final specification it was one of the obligations on a patentee that he should specify the best mode which he knew of carrying out his invention. If he did not do so, his patent could be assailed. Another matter overlooked by the Lord Ordinary was as to what was necessary to sustain a patent for a combination. He quoted a decision of the House of Lords to show that where they had a patent for a combination of mechanical parts, they did not require to specify the merits of any separate part of that combination, and said that if that were so, it was much less necessary in a provisional specification, where only the general nature of the invention had to be shadowed. Haddan's patent did not pretend to be for a new discovery since his provisional specification, but, as the title bore, it was an improvement on apparatus. Having quoted the description of the commutator in the final specification, counsel said their lordships would see that, so far from having claimed a separate invention, the patentee had taken the words in his provisional specification to describe his total combination. The Lord Ordinary seemed to think that if they claimed a combination, they could not carve anything out of that combination; but that was absolutely inconsistent with the principles of patent law, as they could make as many ubordinate claims as they could get out of the combination.

Lord Adam: Suppose a man invented and patented a combination of two things entirely new, and another person took one of those things and combined it with another thing of his own entirely new?

The Dean of Faculty: Yes, I think he could. It had been held that if they had a combination of, say, a dozen parts, an infringer would not escape because he left out one or two from his machine, as he would infringe the combination. In the case of Harrison, in the House of Lords, Lord Chancellor Cairns gave it as his opinion that "if it is clear that the claim is for a combination and nothing but a combination, there is no infringement unless the whole combination is taken." In that case, not only was the competency of claiming subordinate parts clearly recognised, but the House of Lords held that the claiming alternatively of some parts as new by necessary implication involved a disclaimer of any others. The Dean proceeded to point out that Brush claimed a peculiar form of commutator which combined cylindricity, durability and repairability; and it was evident that the insulating segment, T, was within the general description and general purview and aim of the provisional specification. Mr. Murray had made an ingenious criticism when he said that when Brush came to disclaim and correct his specification, he changed "insulated" to "insulating," and that by the time he came to disclaim he had found out that the segment spaces were "insulating" and not merely "insulated." It was perfectly plain, however, that the object of the space at first was to "insulate" the electric current at that particular part, and that, therefore, that part of his friend's argument fell to the ground. The contrivance for the securing of the segments, S and T, more firmly and properly was purely a mechanical function, and, therefore, here also his friend's argument that it was an electrical function that was intended was unsound. The Lord Ordinary was with him (the Dean) upon the next question—namely, whether Wilde's or Varley's commutator was an anticipation of Brush's. No doubt in Wilde's commutator the shaft was used as an electrical equivalent for a wire; but Brush's commutator claim was for a combination, and while in Wilde's the shaft was an electrical equivalent for a wire it was only for one wire, and could only work with an armature with one bobbin, in Brush's they could have as many rings of segments as they liked, and adapt it to the superior work that had now to be done. Another difference was that while in Brush's they had an insulating hub, in Wilde's, with the shaft doing electrical work, they would have considerable leakage of electricity, seeing that the shaft was in connection with the iron frame-work of the machine. Therefore Brush was superior to Wilde in that respect. Then, again, comparing Brush's with Varley's commutator, while in the former the wearing segments were detachably attached by means of a screw, in the latter they had to be broken off with a cold chisel or crowbar, with the result that the machine was damaged. Further, comparing Brush's method of attachment—a screw—with Varley's—a nail or rivet, the advantage was all on the side of Brush. No doubt Varley's came very near Brush's with regard to the mechanism combination, but it did not satisfy either the discription in Brush's specification or the advantage claimed for it. He now passed to the question of compound winding. Mr. Murray had said that neither Varley nor Brush knew of the advantages, or the material advantages of compound winding at the date of their patents. Mr. Murray could not dispute that there was in Brush's publication a full, complete, and clear disclosure of compound winding, nor could he dispute that until Brush made that invention, in 1878, compound wound dynamos were never even used, nor in the market. Now there were thousands of them, and whether or not Brush was anticipated by Varley, it was Brush and not Varley who had made that mechanism useful to mankind. While Brush's machine had become a world-wide success, Varley's—which was an experimental machine—was stowed away among rubbish in Siebe and Gorman's, and was never heard of until it was resuscitated for the purposes of the Crompton case.

Lord McLaren: Varley did not make any more than the one machine?

The Dean of Faculty: No.

Lord McLaren: How can a man make an invention and never try to make it a commercial success?

The Dean of Faculty: Exactly. That is what we consider conclusive in this case.

Lord McLaren: Probably he made the world a present of the machine, seeing he allowed the patent to lapse?

The Dean of Faculty: But apparently he did not make the world any the wiser or the better. His machine was left hidden and out of sight until somebody thought it might be useful in a legal case; while all the time Brush's machine was in the market.

Lord McLaren: The one was a capitalist with a powerful company at his back; the other was a poor inventor who had not the means to make any use of his invention.

The Dean of Faculty: I am not sure that that is a fair way of putting it, because Varley entered into partnership with Siebe and Gorman on this machine. Proceeding, the Dean of Faculty said that while it might be true that Varley did not appreciate the value of his invention, it was not true of Brush, because Brush in his specification showed by his description that he appreciated what he invented. Mr. Murray's point was that there was no incandescent lighting at the time. No doubt there was very little; and while Brush might not have seen what fine measures of adjustment might ultimately be required to secure constant potential, he certainly devised and executed a mechanism which necessarily could not help making a very near approach to constant potential, and which did make as great an approach to constant potential as appeared to have been necessary at that time for electro-plating. It appeared from Brush's description that his great aim was to get constant electromotive force or potential as the result of his arrangement of the magnetic field; and therefore electromotive force or constant potential was distinctly disclosed by Brush. The Dean proceeded to address himself to the question whether Varley had disclosed compound winding in his specification. He contended that the specification must be such as would enable a workmen to put together the machine which was invented from the description and the drawings. If a workman could not upon being provided with the specification and drawings make the machine, then the patent was ineffectual, because it was not practically useful. He submitted that there were some things that would not do when they were dealing with a patent for a mechanical invention like this. It would not do merely to shadow out an idea which might be carried out in various ways, unless the patentee told how this should be carried out. Then, again, if the description were of such a character as to be misleading, it would not be a proper one; it must be of such a character that a man would understand the description and work out a proper result. It would not do merely to have an idea unclothed with particulars. Supposing Varley had it flitting through his mind that he would like to get these two currents round the magnets, but if he never showed how such a thing could be done, how the connection could be made up, and did not describe the invention so as to prevent misconception, then he did not fulfil the conditions required of him. But on the question of fact, whether the description was a proper description, it became vital to see whether the facts were disclosed, because, as he had pointed out, this was not a case in which Varley conceived an idea without ever having the opportunity of carrying it out. He worked at it for months, and made up a machine which failed. The reason why Brush, on the other hand, succeeded was that he drew up a proper specification, and went into the market with his completed machine. They got some light on the matter from Varley's own evidence. There was no doubt he was a man of great ingenuity, but without the staying power to work his ideas into practical form. While he seemed to have visionary or floating ideas, they could not be practically put together, But perhaps that was less wonderful when they remembered this, that, so far as they could gather, Varley never made an experimental machine before he took out his patent. Most people who came into Court with a complex machine consisting of many pieces generally found that they had had to try and correct before they ultimately made their machine.

The Lord President: That is a little dangerous, because you are apt to have the idea stolen in the course of the experiment.

The Dean of Faculty remarked that there was nothing useful about the matter at that time. Varley seemed to have launched this general description, and then proceeded to see whether it would work. Although there might be dangers attached to experiment, they were certainly not those dangers of first adumbrating something in writing and then trying if it would work. The trial in this case proved that it would not work, and although 14 years had elapsed since then, no machine except that which was taken from Siebe and Gorman's yard was ever made, and no machine ever succeeded. It would require in that state of the fact that they should be very clear upon the paper description that this invention was disclosed in the sense he had explained, that was to say, as to its being a combination of mechanical parts so disclosed as to direct the construction of this machine. If he might venture to make a remark about the Lord Ordinary's judgment on this head, he would say that the Lord Ordinary, in dealing with the evidence, made a great point of Sir William Thomson's evidence. Lord Trayner said that Sir Wm. Thomson, in dealing with Varley's specification, "finds that there are some things inconsistent with series shunt; that he has been puzzled in trying to understand the description, which contains some words of a misleading rather than instructive tendency, and he concludes that an ordinary skilled workman would not in 1876 by Varley's description have had disclosed to him the system of series shunt winding. That opinion certainly undergoes modification in the course of his examination, for he concludes his evidence in chief (on this part of the case) by saying that he thinks 'it quite probable that in 1876, he (the ordinary skilled workman) might have been led to series shunt by these descriptions.' His cross-examination, however, brings him still nearer to the view which I have taken. He says: 'The whole passage is consistent with series shunt winding except the partial inconsistency of the first lines, which is not an absolute inconsistency.' On the whole, I think Sir Wm. Thomson may fairly be claimed by the pursuers as a witness in support of their views." In that sentence of Sir Wm. Thomson's about the consistency with series shunt they got an indication of how Lord Trayner had fallen into a mistake in this matter. It was not enough, the Dean of Faculty contended, that they might find in some of the passages of a long description a few lines, and say that these few lines were consistent with a specific invention. If they were consistent with that, they might also be consistent with a dozen other things. Before a thing could be a disclosure of a machine it must direct a man how so to make it that he would be certain of the result. He was not merely to get a description of a thing consistent with one thing which might be consistent with a dozen other things. He must get a description which marked out one machine from all others. While there were some lines in the specification which might be extracted out of this description which would be consistent with compound winding, yet he disputed that consistent and description were synonymous terms. Then again, a great peculiarity of this case was that if Varley should prove to be the inventor, after having got an enormously valuable invention, he did not claim it. He described it, did not draw it, and failed to claim it. All these things were a very bad start in holding that he had made a pure disclosure. In considering the question whether disclosure was made, the question must be dealt with as affected by the circumstances which surrounded the patent at the date it was issued or published. The question was not whether a a man in the year 1890 or 1888, reading the description, would gather this out of it with what had now become common knowledge, but what an electrical workman of ordinary skill of 1876 would be able to extract from it. His description did not apply to compound winding. They were told in the specification that a part of the electricity went to maintain the magnetism, and the remaining portion was used to produce the electric light. That was not in accordance with series shunt. Any workman who read that would be apt to carry with him into any subsequent reading of the specification that there was a final division of the electricity into two volumes devoted to two separate purposes. That was a very bad start towards compound winding. Then Varley proceeded to state that there were several well-known ways of doing this, but the method he preferred was to wrap the soft iron magnets with two insulating wires, one having a larger resistance than the other. The circuit of larger resistance was always closed, and the circuit of less resistance was used for the electric light. It was said that here they came nearer to compound winding. It was said that the previous two lines he had referred to described compound winding, and now Varley proceeded to say that there were well-known ways of doing this—that there were well-known ways of compound winding at a time when it had never been known. If an ordinary workman of that time had been started on this wild goose chase by being told to separate the total electricity into two parts, and then was informed that there were several well-known ways of doing this, what would he do? He would look to his common knowledge to see where were the several well-known ways of doing this, and he would think of the ways which were all inconsistent with compound winding. Varley went on to describe something which he (the Dean) did not dispute might be consistent with compound winding. What he said as to the method he preferred of wrapping soft iron magnets with two insulating wires, one having a larger resistance than the other up to a certain point was concerned with compound winding, because they had in compound winding soft iron magnets wrapped with two insulating wires, and one had a larger resistance than the other. They had a shunt wire with a large resistance and a series wire with a small resistance, but they were not told where those wires came from, and how they were coupled up. They might have come from the armature and they might have come from the outside altogether. Varley told them that there were some well-known ways of doing it, and no human being had ever done it in this way before. While he admitted that these few lines in Varley's specification involved general ingredients, that they found in compound winding it was not enough that it should only be incidentally mentioned and was inconsistent with something else, and was not calculated to instruct, as it did not instruct any human being how to do it. Varley then went on to mention two circuits, the one of larger resistance being always closed, and the circuit of less resistance being used for the electric light. This paragraph was wholly inconsistent, except one line, with compound winding, Varley came back in the last line of the paragraph to a total and final separation of his electricity, one part of which was exclusively devoted to magnetism and the other to the electric light. If Varley had had any glimmerings of compound winding in the lines in which he spoke of two wires that glimmering had vanished when he went back again to talk of total severance. In this connection he might point out that they were entitled to consider the opinions of men of electrical skill as to what the workmen of 1876 would have understood by this description of Varley's. Many of the scientific witnesses who had given evidence had stated that ordinary workmen, in 1876, would not have been able to make this machine from the specification. He referred to Sir Wm. Thomson as being perfectly distinct upon that matter.

The Lord President: Mr. Murray thought he had converted Sir William into a witness for the other side?

The Dean of Faculty: Yes; but Mr. Murray admitted that so highly skilled a witness as this allowed that a workman of more than ordinary skill would find the description confusing and conflicting. But Mr. Murray put a great many questions to Sir Wm. Thomson, and as the result of drawing his attention to things scattered over the whole specification, Sir William had some of his difficulties removed. But a workman of ordinary skill had not Sir William's advantages. He had got to read the specification with the knowledge he had at the time. It would not be an answer to the Brush Company's case to say that some might read Varley's specification in that way, and some might read it in another. If it was to be read in these different ways, it did not enable a workman of ordinary skill to get at Varley's meaning. It was sufficient for the defenders to show that this incidental description of compound winding had never come to anything, and that it never instructed a human being, and was lost sight of until the machine which Varley had constructed was excavated for the purposes of Crompton's case. Further, the only drawing which Varley prepared in connection with his specification did not show compound winding at all, but only series winding. As a whole, therefore, the specification and drawing did not disclose compound winding. It would not do to take a line out of the specification at one place about a commutator, and a line about a wire at another place, and piece them together. There must be clear and definite instructions, and there were no instructions adequate to construct a machine. Now the next point he would deal with very shortly, unless their lordships desired him to speak upon it. He referred to the model of the machine which was made in Mr. Brown's works in 1888 from Varley's specification. The Court must remember that this was in 1888, when compound winding had been the property of the world through Mr. Brush for ten years. Was it credible, he asked, that they could find an electric workmen in 1888 whose mind was not full of the idea of compound winding?

Lord Adam: They took out an apprentice to do the work who knew nothing about compound winding.

The Dean of Faculty: But compound winding was spoken about to the men. It was, therefore, no fair test to say that electrical workmen in 1888 could make this machine from the specification. Let them find men who could do so in 1876.

The Lord President: Are we not losing sight of the great rule that the construction of a specification is for the Court?

The Dean of Faculty: I think that is so.

Lord Adam: Yes, but you can give us evidence to instruct the Court as to what its state of mind should be when it comes to decide the case. (Laughter.)

The Dean of Faculty, continuing, said all he wished to state of this point was that if the specification did really disclose compound winding to men who knew it already in 1888, it did not disclose it to the men who did not know it in 1876. There was no doubt that Varley's ideas were visionary and in the air, and that the real inventor was he who brought them down to earth and made them of service to man. The only remaining point was that of usage, and was one that might be dealt with very shortly. The evidence upon that matter had been put before their lordships. The history of the machine was that Varley, after having made a partnership with Siebe and Gorman for working out his patent, got very favourable opportunities of trying it. These gentlemen seemed to have been skilled mechanicians, and the machine received every advantage from their skill and knowledge. For months they worked at it, and it turned out a failure. That was the only working machine said to have ever been made under this great invention. Now he thought the Lord President had said that in order to justify usage, there must have been trial by way of use. There must be trial by use, and not merely by experiment. Well, experiment was the only use, and Varley himself described it as an experimental machine. After it had been tried as an experiment, the only things that could be said regarding any use of it was in photographing an ice machine by the light from the lamp attached to it, and in lighting a tank in which some divings had taken place. These were things that were done incidentally in the course of the experiments. The machine never was shown to have been lighted or used for the purpose of doing useful work, but when it was lighted in the course of experiment, these things were done. Their lordships could come to no other conclusion than that the machine was a failure.

At the conclusion of the Dean of Faculty's address, the Court adjourned for the day.

(To be concluded.)

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(Continued from page 687.)

SUPPLY REGULATIONS.

These have been subjected to less alteration than the safety regulations. The variation of standard pressure permitted has been reduced, and in the new draft it is proposed, as already stated, to introduce the idea of a pressure to be declared at the consumer's terminals, which is not to vary more than 4 per cent., and the variation of which may be tested for the consumer on his application by the electric inspector.

It is also proposed to take advantage of the powers of the transformer system and provide that the consumer supplied from a transformer on his premises shall have the choice of two pressures given him, one about half the other.

No doubt many of the regulations that have been made are open to criticism; but I would point out that they are in every case the result of very careful consideration, and that observations on them from many different points of view have been submitted, and given, as far as possible, their due weight. It is not unlikely, therefore, that a criticism, even from a high electrical authority, may be unjust and erroneous, from the critic not being acquainted with all the circumstances and conditions which have guided the Board of Trade; and it should also be borne in mind that the Board are empowered to alter any regulations issued by them, or to repeal them and issue fresh ones, should the progress of electrical discovery and further experience make such a course desirable.

And whatever imperfection may become apparent in these regulations, I can confidently affirm—and I feel sure that this proposition will receive the support of those among you who have experience of its methods of procedure—that the Board of Trade has been guided solely by the desire to do the duty imposed upon it by Parliament, and to serve the best interests of producers and consumers alike.

And now, I should like to say a few words about the standardising laboratory. You are probably aware that the Board of Trade have, in deference to the wishes of the large body now interested in practical applications of electricity, as expressed by a powerful deputation to the President last year, undertaken to provide something in the nature of a testing establishment for instruments intended for the measurement of electrical quantities, analogous to the Standards Department of the Board of Trade for weights and measures of the more gross and material quantities. They have also taken powers under the Weights and Measures Act of last Session to undertake such testing and verification, and to charge fees for it; so that these verifications, whatever their scientific value, will possess a legal value.

A general scheme for the scope and working of this laboratory was drawn up very carefully last year by a committee of your Institution, in connection with which I should like to mention especially the hard work done by Dr. Fleming, in a cause which he has given abundant proof that he has at heart. The general idea embodied in this, in which I personally entirely concurred, is that the thing should grow from small beginnings. This, I think, is the English way, and I need only point to the present position of our own Institution as an example of its success. Our more impressionable neighbours on the other side of the Channel like to start these things in a different way. They must have something grand and striking, and of course there is much to be said for this view, if you have the means to carry it out; but it sometimes leads to, as it were, setting up a steam hammer to crack nuts. No doubt the steam hammer can do it very well, but a pair of nutcrackers is cheaper. Now I can promise that there will be nothing grandiose about our laboratory—we are starting with a very ordinary pair of nut-crackers.

It is hardly necessary to observe that the small beginnings idea was the part of the scheme most to the taste of the Treasury; in fact, to use an electrical metaphor, my Lords would have liked our electric particle to have acquired its potential of doing work by starting in the legitimate way at an infinite distance from the charged body (the national purse), and to have been a long time on the road, too. However, let us not forget that if we are electricians we are also taxpayers!

Now what we hope to do in this laboratory is, first of all, to get the true values of the electrical units, within a very small possible percentage of error. We are not tied to the so-called legal units, which I may remark have no legal value in England; but with the assistance of Lord Rayleigh and the Standardising Committee of the British Association, we hope to get even nearer the truth than was arrived at with this set of units. Secondly, having got there, we hope to keep there by well-devised checks and frequent reference to the fundamental measurement. This, as we are at present advised, will be the measurement of current by the quantity of silver deposited from solution in a determined time. Thirdly, so soon as we are satisfied that sufficient accuracy and permanence has been arrived at with our instruments and methods, we shall be ready to receive instruments, either for simple verification in the case of ordinary commercial instruments, at a small charge for each reading, or for thorough testing and certification in the case of instruments submitted as sub-standards.

The rules and charges have not yet been drawn up, but it is probable that instruments will be required to be marked with a clear and intelligible scale—whether of degrees or volts or ampères, &c., is quite immaterial; the extreme range of the instrument must be given approximately, and whether it is intended for alternating or continuous currents or pressure, or for both. The reading given by the instrument on its own scale for each current or pressure asked for will be taken, probably, in all cases both with increasing and with decreasing readings.

No extreme accuracy will be guaranteed for these readings, but it is hoped not to exceed an error of ½ per cent. from the true value. Of course, in the case of ordinary commercial instruments, we should give no sort of guarantee that the instrument will remain constant for any time, or under different conditions.

Sub-standards will be subjected to long and rigorous testing, including the determination of their variation under different temperature and the permanence of their constants. I am afraid, however, that in most cases there will be some difficulty in giving any guarantee of the constancy of an instrument after it has passed out of our hands.

The power for laboratory purposes will be supplied from two batteries of accumulators—one of four very large cells simply to give steady continuous currents up to 2,000 ampères; the other, consisting at first of 100 smaller cells, will be used directly for continuous pressures up to 200 volts, and also to run the machinery. The machinery referred to is two pairs of dynamos, one of each pair being energised by the cells as a motor and driving the one connected to it as a generator. One of these generators will be an alternate current machine, and the other a high pressure continuous current machine. In connection with the alternate current machine we shall have a set of transformers. In this way we hope to get currents practically as steady as if taken direct from the accumulators, and in the case of alternating currents and pressures any frequency within the limits of practice. The limits we propose to work up to at first are:—

Continuous current	2,000 ampères;
„ pressure	2,000 volts;
Alternating current	500 ampères;
„ pressure	2,000 volts.

The building and alterations necessitated are now nearing completion, and we hope to have the laboratory in working order in about two months' time.

DISCUSSION.—MAY 15TH, 1890.

(Authorised abstract.)

Mr. CROMPTON expressed his opinion that the electric lighting industries had suffered considerably from over-legislation, and he disagreed *in toto* with Major Cardew's statement that the Act of 1882 did not do the amount of harm generally attributed to it. He admitted that over-speculation in electric light patents had a depressing effect, but he himself could vouch for the fact that the Act of 1882 prevented a large central station, in which he was interested, from being carried out. Had this been proceeded with, experience for which we had now to go to America would have been gained first hand. Unnecessary legislation had also caused immature and incomplete schemes to be brought forward, and seriously interfered with the natural development of the industry. The question of sites for stations had been placed in an unsatisfactory condition, for under present circumstances it was necessary to keep their positions secret, and this necessity caused hurried designs and workmanship as well as increased cost. He firmly believed that the old method of obtaining private bills, as for gasworks, would have been far more satisfactory to all than the present system of provisional orders, and he felt quite sure that the gasworks clauses could have been easily modified to make them applicable to electric lighting stations. Whilst fully admitting that the Board of Trade had done all in its power to make the Acts workable, and that the thanks of all interested were due to the officials for the great efforts they had made, he could not help thinking that the tendency of modern legislation was to interfere too much, and to show people how to do their own work. The case quoted by Major Cardew as to consumers being entitled to the choice of two pressures, one about half the other, was in his opinion one of undue interference, for it was quite as much a pure commercial question as whether a grocer should make up his tea in pound or half-pound packages. Another case of injustice occurs where the supplier is required to provide larger terminals when a greater supply is needed by a consumer than he originally estimated.

Mr. G. OFFOR endorsed Mr. Crompton's remarks about the Board of Trade officials being always anxious and ready to deal practically with the questions which arose. He also thought that we suffer from over-legislation. One serious defect of the present system was the inordinate length of time required to obtain a provisional order, for the preliminary order must be applied for in July whilst the confirmation of the order cannot be granted until August in the following year. Should an unexpected dissolution of Parliament occur in the interval, the consequences would be very serious to the applicants. He submitted that a great improvement might be effected by materially shortening the time between the application for, and comfirmation of, provisional orders; or, better still, by avoiding the necessity of obtaining confirmation Bills. As this confirmation is not required for licences, he thought orders might be treated similarly. As to the position of local authorities being more favourable than that of private companies under the Acts, he thought this a distinct advantage, for it would facilitate procuration of capital for carrying out lighting schemes, whilst private companies would obtain the work without incurring all the risk. The appointment of electrical inspectors and consulting engineers were points on which he believed local authorities were somewhat confused; and to show the state of some minds on the subject, he cited a case in which a local authority wished to appoint an inspector, but stipulated that his salary was to be paid by the undertakers.

Mr. J. **Shoolbred** thanked Major Cardew for the concise account of provisional orders which he had given to the Institution. There were two points to which he desired to direct attention in connection with such orders, viz., the necessity for byelaws and the question of overhead wires. Bye-laws, he said, were becoming more and more important for the protection of undertakers rather than for customers; this, he was glad to see, had been partly recognised by the Board of Trade in granting access to consumers' premises in some cases, but facilities for examination of fittings, &c., were still required, for vexatious customers can, and do, throw serious difficulties in the way of undertakers. As regards overhead wires, he pointed out that considerable complication had been introduced by the Board of Trade, legalising them to some extent, for it would lead to unfair competition. Many overhead wires had been erected without statutory powers, and if these were permitted to remain, the companies or persons in possession, although they did an illegal act in erecting them, would be allowed a great advantage over another law-abiding company in the same district which was compelled to put its wires underground. Referring to meters, he asked if any had been certified, and whether steps had been taken towards the formation of branch offices at which meter tests could be carried out. In the event of such offices being established, he wished to know if they would be representative of the central office. Speaking of the clauses in the new model provisional order relating to the pressure being declared at the customer's terminals, he pointed out that in some cases a consumer may declare a pressure which it would be practically impossible for the undertakers to supply.

The discussion was adjourned to the 22nd inst.

May 22nd, 1890.

Mr. A. A. **Curtis Hayward** remarked that Major Cardew's paper touched lightly on the appointment of "electric inspectors." He considered the vesting of such appointments for the Metropolitan district, in the London County Council, a regretable incident, and was glad to note that in future orders the right of appointment would be vested in the Board of Trade. The appointments were, he said, at present very important, for the public had been somewhat alarmed by the sensational accounts of accidents in America. The knowledge that properly qualified inspectors were to be appointed would tend to restore confidence and give great satisfaction to the community. His opinion as to the future importance of electric inspectors did not coincide with that of Major Cardew, for he believed theirs would be a case of degeneration rather than one of development. He could not agree with Mr. Crompton about over-legislation, and thought the latter gentleman overstated the case when he said that the gasworks clauses might have been easily modified to cover electric supply. A real need for a special Act existed, for there were many subjects in electric supply, such as overhead wires, &c., which were quite foreign to gas distribution.

Mr. **Emile Garcke** said that he was not prepared to discuss the details of the regulations in the face of Major Cardew's statement that criticism from even a high electrical authority might be erroneous. He would rather confine himself to the historical facts. The Parliamentary history of electric lighting was unique, and the rapid changes that had taken place in the industry were phenomenal. The first select committee (he said) was appointed in 1879, when the commercial possibility of incandescent lighting was unknown. Its fair report encouraged contracting firms to promote Bills in Parliament. In the spring of 1882 another select committee was appointed, and in the same year the memorable Act of 1882 passed. Although its results were lamentable in one respect, he thought it not an unmitigated evil. After detailing the various attempts to remedy the defects of that legislation, resulting in the Act of 1888, he pointed out that no time had been lost, and that progress had been comparatively rapid. He laid great stress on the exceptional character of the legislation, even of the amended Act, saying that no other industry had ever been placed under such adverse conditions, excepting, perhaps, by the Tramways Acts, but even this was much more favourable to the contractors than the Electric Lighting Act of 1888. The exceptional character arose from the fact that Parliament refused to put electric lighting corporations on anything like the same footing as gas companies, and thus the former had to compete on very unfavourable terms. It was in the power of the gas companies, by foregoing their dividends for a year or two, to completely crush electric companies; for, in addition to their power to pay accumulative dividends, they had the advantage of practically perpetual tenure, whilst the electric companies were limited to 42 years. As regards local authorities, he complained that, according to present regulations, it was in their power to stifle electric lighting, and as many of them were largely interested in gas, he argued that it was not right that the electric companies should be placed in such a difficult position. To show how vexatious local authorities may be, he quoted a case of a central station established in the early days of electrc lighting. The work was carried out satisfactorily by overhead wires until such time as regulations were issued by the Board of Trade stating that all wires must be put underground. In the face of the 21 years' purchase clause, it was financially impossible to comply with the regulations. When the amended Act was passed in 1888, the company applied for a provisional order, but were opposed by the local authority, which was at that time negotiating for the purchase of gas works. He was not aware that any other kind of vested interests had been similarly treated.

Mr. K. L. **Murray** expressed the great pleasure he experienced in hearing the discussion on such an important subject, and at being in the presence of so many eminent persons on whose sayings and doings they, in Australia, were so largely dependent. In Victoria, he said, they had no Acts of Parliament or regulations to control electric supply, and until recently, they had no rules. Last year, however, the Victorian Institute of Engineers had drawn up a set of rules, based largely on those issued by this institution and the insurance companies. He did not agree with those who say that electric supply needed no regulation, for defective workmanship should be carefully guarded against,and for this object rules or regulations were necessary. An Act of Parliament, he said, was now expected in Victoria, and the present discussion would aid in framing the Bill. A knowledge of what to avoid, as well as what to do, may, he hoped, lead to a model Act, from which perhaps the mother country might copy with advantage.

Captain **Rowan** said that in Australasia, where he had been engaged in introducing electric lighting, difficulties arose from want of legislation. No public body had power to give authority to lay mains or to erect overhead wires, &c., and in consequence, matters had come to a deadlock. Mr. Murray, he said, had told them that legislation had been delayed until it was known what is to be done here. He hoped that the present discussion would materially assist those on the opposite side of the globe to hit the happy mean, whereby public safety may be assured, without the industry being hampered.

Mr. H. **Human** disagreed with what Mr. Crompton said about the injustice of compulsory supply at either of two pressures, and pointed out that a grocer who made up his tea or sugar in pound or half pound packages had not a monopoly granted to him for 42 years. In his opinion there was no particular hardship to the undertakers in the regulation, whilst it was a distinct boon to customers. He thought Mr. Crompton, in his remarks about the gas and water companies, had overlooked the fact that they had been sources of complaints for years. His comparison of electricity with gas and water was not legitimate, for in the former case, where such a subtle agent as electricity was dealt with, consumers were much more at the mercy of undertakers. In America, he said, where the industry had not been hampered by legislation, there had been so many accidents and fires that the public were now appealing for control, and the wish had been expressed that a body analogous to our Board of Trade was in existence there. Speaking of safety devices, he wished to see their use made compulsory where the pressure exceeded 1,000 volts. In conclusion, he said that the Acts of Parliament, if harsh, were necessary, and he hoped that those who advised the Board of Trade would hold the scales equally between consumer and undertaker.

Mr. A. **Siemens** said it should be borne in mind that the objects of the legislation were two-fold: 1st, To empower electric supply companies, &c., to lay mains in the public streets and conduct the business of supply in a manner recognised by law; 2nd, To recover charges for supply made to consumers. Both these aims were intended to confer powers on companies which otherwise they could not possess. Originally, he said, the Board of Trade had power to grant provisional orders without the consent of the local authority, but in the later development neither licenses nor orders can be granted without such consent being first obtained. In contradistinction to the case quoted by Mr. Garcke, he said that in one town a company had started a station in spite of the fact that the local authority had obtained a provisional order; subsequently the company wanted to claim compensation for loss of vested interests. There was only one point in Major Cardew's paper which he considered disputable, and that referred to testing stations at pillar boxes. In his opinion they are unnecessary, for a recording instrument in the central station should fulfil all requirements. If, however, the local authority wanted a separate station, that could be easily arranged.

Mr. J. S. **Fairfax** hoped that no hard and fast line would be laid down as regards the kind of instrument to be used at testing stations. In his opinion, the paragraph in Major Cardew's paper referred to some kind of dial arrangement, but he thought one on the deposition principle may be more correct.

Mr. Ed. L. **de Segundo** did not agree with Mr. Crompton about the Board of Trade having gone too far; in fact, he thought it had not gone far enough as regards protection of the public by making regulations for insulation tests. He knew a case where a 1,000-volt circuit was tested at 100 volts, and he pointed out that to test a steam boiler intended to work at 100 lbs., with water pressure at

10 lbs., would be considered ridiculous. The testing of house wires was also very important, for in one case he was assured that there was no defect in the insulation, for in the contractors' tests no indication of a leak was obtained. On applying Evershed's ohmmeter with about 100 volts a dead earth was indicated.

Mr. **MORDEY**, in referring to the question of safety devices, said it was time the subject was settled. The method of earthing the secondary was, in his opinion, perfectly safe. Great opposition had been made, particularly by the insurance companies, to its adoption; but the reasons for such objections were not forthcoming. As far as he could see, there was no danger whatever with the secondary volts at 100, for by earthing the middle of the secondary the greatest difference of potential possible was 50 volts. Besides, the method had also the advantage of weeding out all rotten installations. They had used the method on the continent, and found it quite successful. The fuses, however, often go, owing to persons inserting penknives, &c., into the switches for the object of obtaining agreeable medical shocks. As regards the Cardew device, he pointed out that its cost was not an unimportant item; moreover, it was automatic, and might not go off, and generally the fewer automatic arrangements there are about an installation the safer it is.

Mr. A. P. **TROTTER** enquired what excess of current was required to let the fuses off, to which Mr. Mordey replied that about 20 per cent. above the normal was the ordinary average; in his opinion, such currents could not give rise to fires.

Dr. **FLEMING** asked what occurs in the case of an earthed secondary when the primary is also earthed? In Italy, where they had had considerable experience in alternate current distribution, the tendency was in the opposite direction, for the greatest care was taken to perfectly insulate both primary and secondary circuits. He himself had used an earthed secondary at the Inventions Exhibition, and had found no difficulty, but he wished to ask Mr. Mordey what his experience was.

Mr. **MORDEY** said that no difficulties had been met with.

Major **CARDEW**, in reply, pointed out that the Board of Trade could not adjust or redress any wrongs, for such changes in the law must be made by Parliament. With respect to the declaration of pressure at consumers' terminals, he said this was rendered necessary by the introduction of transformers, for it was more difficult in such cases to know the fall of pressure in the distributing mains than in continuous current distribution. He then read the following draft which is to be inserted in the new model orders:—"Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 115 volts, or less than 45 volts, if continuous or the equivalents thereof respectively, if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three wire system the central terminal shall, for the purposes of this regulation, be considered to form a pair with either of the outer terminals, and similarly for multiple wire systems; and, in the case of a transformation of energy on the consumer's premises the undertakers shall give the consumer the choice of a supply at either of two pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure." In drafting this clause, he said, advantage had been taken of the flexibility of the transformer system in the interest of consumers. Mr. Shoolbred's questions with regard to meters were answered in the paper itself, for he would there see that they were to be certified by a local inspector, and be of a pattern approved by the Board of Trade. Mr. Murray's remarks about contacts between telephone and electric light wires needed careful consideration, for this was one of the chief sources of trouble and danger where high pressures are used. To Mr. Human he pointed out that the issue of a provisonal order conferred no monopoly whatever. In reply to Mr. Siemens he could not say why the change respecting the consent of local authorities had been made by Parliament. Such, however, was the case, and the Board of Trade could not dispense with that consent except in very special cases. As regards testing stations he thought the arrangement he had suggested would be more satisfactory to the general public than the use of pilot wires and instruments fitted in central stations. To Mr. Fairfax he explained that the reference to dial instruments in pillar boxes was intended for indicating and not for recording instruments. Speaking of safety devices, Major Cardew said the plan of earthing the secondary got rid of some defects when the earth connection was substantial, but he thought the fire risks were increased by such a procedure. He had heard of fires being caused through a small leakage current having gradually charred wood, and ultimately set it alight. The apparatus bearing his name was, he said, admittedly automatic, but its action depended only on gravity and electrostatic attraction, and neither of these were likely to alter.

Physical Society.—June 6th, 1890.

Prof. W. E. **AYRTON**, F.R.S., President, in the chair.

Mr. H. **TOMLINSON**, F.R.S., read a paper on "The Effect of Change of Temperature on the Villari Critical Points of Iron." This, he said, was a continuation of the paper he read before the Society on the 21st March, and the methods employed was the same as then described (see Phil. Mag., Vol. 28, p. 394). Since then, however, he has made experiments at various temperatures, up to 285° C., the temperature being determined from the resistance of a platinum wire whose temperature coefficient was carefully determined. The following table shows some of the results obtained with a well annealed iron wire, 1 mm. in diameter, which had been repeatedly heated up to 300° C., and cooled to the temperature of the room until the temporary permeability with various loads attained constant values at both temperatures.

Magnetising force in C.G.S. units.	Load in kilogrammes for which permeability is the same as for unloaded wire at temperature				
	12° C.	76° C.	167° C.	244° C.	285° C.
2·84	4·7	5·6	5·3 and 12	5·7 and 10	None.
3·70	2·5	3·2	3·6	4·2 and 11·5	4·7 and 9·9
4·8	1·8	2·5	2·7	...	3·1 and 12·3
7·69	None.	None.	None.	None.	None.
10 40	,,	,,	,,	,,	,,
15·32	,,	,,	,,	,,	,,

Curves from which these numbers were obtained are given in the paper, and in the load in kilogrammes and percentage change of temporary permeability are plotted. From these curves and table it will be seen that if the first points in which the curves cut the load line be considered, then at all temperatures the Villari values increase as the load decreases. If, however, the second points be taken, the critical values increase both with load and temperature. In both cases the Villari value is increased by rise of temperature. From the curves it follows that rise of temperature reduces the total variation of permeability producable by loading. A table showing the temporary permeability of the unloaded wire at the various temperatures accompanies the paper.

A paper on "The Diurnal Variations of the Magnet at Kew," by W. G. **ROBSON** and S. W. J. **SMITH**, was communicated by Prof. Rücker. In some preliminary remarks, the Professor pointed out the great advisability of having the results of magnetic observations at various observatories reduced and published in the same manner, and for the same periods. In order that this may be effected, the methods of reduction must be reliable, but not very elaborate. The Greenwich plan is too laborious to be generally adopted, but the method suggested by Dr. Wild (Rep. Brit. Ass., 1885, p. 28), in which the mean diurnal variation is obtained from measurements on five quiet days in each month, is feasible. With a view to further testing the reliability of this method the work described in the paper was undertaken. Mr. Whipple had made a comparison of the two methods for the years 1870–71–72, with the result shown in the following table:—

$$\left.\begin{aligned} K_s - K_w &= 0'.7 \text{ (minutes of arc)} \\ A - K_s &= 1.2 \\ G - K_w &= 1.6 \end{aligned}\right\}$$

Where K_s is the mean diurnal range at Kew as obtained by Sabine's method,
Where K_w is the mean diurnal range at Kew as obtained by Wild's method,
And G is the mean diurnal range at Greenwich by the Greenwich method.

He also found that the mean hourly differences followed same definite law.

The authors undertook the reduction of the Kew observations according to Wild's method for the years 1883, 1886–87; the first was chosen as being a year of maximum sun spots.

The results give :— 1883 $G - K_w = 1'.5$
1886 ditto $= 1'.2$
1887 ,, $= 1'.9$

There is thus a difference of nearly two minutes in the variations at the two places, and this cannot all be accounted for by the method of reduction. Another peculiarity is that the range as calculated by Wild's method is greater by about 0'.5 than that obtained by Greenwich method, although the latter includes days of moderate disturbance. The total range at both places has diminished by about 1'.6 between 1885 and 1887. The paper is accompanied by tables and curves plotted from the differences in the mean hourly readings at Greenwich and Kew for each of the above six years, and a marked similarity exists between all of them. The mean of the six curves differs in no case by more than 0'.4 from the curve for any year. It is thus possible to calculate the Greenwich values from the Kew numbers, and as these latter are published about two years sooner than the former, this fact may be very important.

Referring to the reduction of results, Prof. **RUCKER** said that the Stoneyhurst observers and Prof. Mascart were willing to adopt Wild's method; Falmouth, he hoped, would follow suit, and Greenwich had been asked to publish their results in both ways.

Mr. **WHIPPLE** said that before recording instruments were available, and the numbers were obtained from separate experiments, the labour involved was considerable, and a single large disturbance or magnetic storm might vitiate the result of a whole year's work. Methods were therefore adopted to eliminate these disturbances; of these, that used by Sabine may be particularly mentioned, although declination records have now been obtained for a considerable number of years the cause of the variations still remains unknown. They do not seem to be dependent on temperature or on astronomical facts. He considered it valuable to obtain magnetic data from different parts of the earth, but comparisons were only possible when all are published on the same plan. This he hoped would result from the efforts of Profs. Rücker and Adams. When this is accomplished, the observations on magnetic force will need treatment; this work will be laborious, and the aid of volunteers like Messrs. Robson and Smith would be of great service.

Prof. W. G. ADAMS said he was glad to see the satisfactory nature of the work which had just been brought before the Society. Usually the mass of figures to be dealt with was so large that the mere reduction was a great undertaking. If, however, the difference between results obtained by the Greenwich and Wild's method was not more than 0'.4, it may be possible to make out the causes of the variations from observations reduced on Wild's plan. He himself would put more faith in horizontal force observations, and wished they could be worked out by some ready method. He hoped the one adopted in America, of obtaining mean curves by photography, may prove satisfactory.

Prof. PERRY asked if a machine would not be made to do the work.

Mr. WHIPPLE said such machines had been used by the Meteorological Office, but they were so elaborate and expensive that clerical work was just as cheap. The method of photographing mean curves had been tried at Kew, but it was open to the objection that accidental disturbances such as those produced by the movement of iron in the vicinity and the approach of cabs, &c., were not eliminated.

Mr. BOYS, referring to the use of integrators, said that for a harmonic analyser his disc-cylinder pattern was preferable to the ball disc-cylinder integrators of J. Thomson, for it is much cheaper, and has less inertia.

The PRESIDENT said the movement initiated by Prof. Rücker would be of great service if it resulted in the numbers obtained at the various magnetic observatories being published in the same way. It was a great advantage to have such men, who were not permanently attached to an observatory, to take up the subjects and suggest improvements. The heads of such institutions were usually too much employed in making the necessary reductions to have time for devising improved methods. In his opinion, greater freedom should be allowed to the chiefs of observatories, for it should be borne in mind that the object of observations is not to produce volumes of figures, but to increase our knowledge. Referring to the reduction of observations, he thought the voluntary services of senior physical students should be more generally accepted, and to this end he suggested that properly recommended persons should be allowed to spend some time in observatories as honorary assistants. This would be of great use to the students themselves and an advantage to the observatories, for the reduction of observations could then be expedited. As regards the accidental disturbances referred to by Mr. Whipple, he contended that regulations should be adopted to render them impossible.

NEW PATENTS—1890.

8241. "Improvements in electric lamp hangers." C. L. JEFFERS. Dated May 27. (*Complete.*)

8242. "Improvements in and relating to electric welding or metal working apparatus." W. R. LAKE. (Communicated by H. Lemp, United States.) Dated May 27. (*Complete.*)

8253. "Improvements in systems of circuits for electric semaphores." J. KRIEGER, F. STITZEL, C. WEINEDEL, M. SCHWARTZ, A. REUTLINGER and J. H. EGELHOFF. Dated May 27. (*Complete.*)

8254. "Improvements in the manufacture of plates for electric accumulators." R. HADDAN. (Communicated by F. Pescetto, Italy.) Dated May 27.

8272. "Improvements in the construction of electrical fire or burglar alarms." S. B. WILKINS. Dated May 28.

8306. "Improvements relating to electric relays." H. H. LAKE. (Communicated by E. F. Law, Russia.) Dated May 29.

8325. "Improved method of preventing injuries to submarine cables, which he designates 'Chafe indicative alarm wires.'" J. M. A. PONCIA. (Communicated by H. Kingsford, Peru.) Dated May 29.

8362. "Improvements in electric locomotives." E. DUMMER. Dated May 30. (*Complete.*)

8393. "Improvements in switches for electrical circuits." B. M. DRAKE, J. M. GORHAM and P. J. PRINGLE. Dated May 30.

8427. "Improvements in electric arc lighting." A. APPS. Dated May 31.

8471. "An improvement in electrically-driven locomotives." E. H. MORGAN. Dated May 31.

8474. "Improvements in electrical switches." C. A. MCEVOY. Dated May 31.

8477. "Improvements in electric switches or apparatus for making and breaking electric circuits." S. F. BEEVOR. Dated Dated May 31.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

2472. "Improvements in secondary battery plates." W. L. WISE. (Communicated from abroad by The Gibson Electric Company of Europe, of Paris.) Dated February 12. 6d. A secondary battery plate, according to this invention, has a raised border, or rim, the base of the said plate being pierced with holes, or perforations. The plate may be made of rolled lead, or it may, if desired, be cast in a mould, the base being pierced by perforations that may be advantageously inclined to the surface of the plate. It is advantageous that the holes, whether mechanically pierced or cast, should be so made that the tool used in producing the perforations raises a lip at the upper side, and a projection, or opening, on the lower surface of the plate. These plates, which from their form may be called "saucer plates," are filled with the active material, or material designed to become active, and the said material entering and filling the above-mentioned perforations, becomes firmly united with the plate. Several such plates are arranged horizontally, alternately positive and negative, to form a cell. The horizontal position of the plates prevents the active material from falling out, and so making a short circuit between the plates, and destroying the battery. 3 claims.

3363. "Improvements in the manufacture of incandescence electric lamps." J. W. EDMUNDSON. Dated February 25. 4d. Claims:—1. For an incandescence electric lamp, a carbon conductor coated with a metallic deposit. 2. Coating carbon conductors for incandescence electric lamps with chromium, in the manner described.

4371. "Improvements in electricity meters." G. HOOKHAM. Dated March 13. 8d. Claims:—1. The arrangement and combination of parts, consisting essentially of an isochronous pendulum, or its equivalent, and a moving part first displaced from its normal position by the action of the passing current to be measured, and afterwards restored directly or indirectly to its normal position by the said pendulum, or its equivalent, the said arrangement and combination being used in conjunction with registering or recording mechanism. 2. Producing the advance motion and preventing the return motion of the registering or recording mechanism of electricity meters by the employment of camel hair brushes, or other brushes made of natural or artificial fibres, arranged so as to act in the manner described and illustrated. 3. Correcting the irregularities of electricity meters caused by excess or defect of the motions communicated to the recording apparatus by the use of a pendulum having a magnetic bob operated upon by a solenoid, substantially as described and illustrated.

6171. "Improvements in means for regulating or controlling electric currents." C. R. HEAP. Dated April 10. 8d. The inventor provides a pair of rotatable friction discs between which is situated a pulley upon some part deriving motion from the generating machine or from the axis of the machine itself, the said discs being carried by or connected with a solenoid or electromagnet included in the working circuit, so that when the current is in its normal condition the discs are both of them out of contact with the said pulley, but when the current decreases or increases beyond the normal, one or other of the said discs is brought into contact with the pulley, and motion in one or other direction is given through the one or the other of the said discs, so as to actuate a device for increasing or reducing the current to its proper normal condition relatively to the requirements for the time being of the working circuit. 5 claims.

6568. "Improvements in dynamo-electric generators and motors." G. E. DORMAN. Dated April 17. 8d. Claims:—1. In a dynamo-electric generator or motor an iron tube, or equivalent structure, containing two interior pole pieces with field or exciting coils arranged around the said pole pieces, the coils being bent or shaped to conform with or fit the interior curvature of the said tube or equivalent structure, substantially as described and shown. 2. In a dynamo-electric generator or motor an iron tube, or equivalent structure, containing two interior pole pieces with sectional field or exciting coils arranged around the said pole pieces, the said coils being bent into proximity to or to embrace the armature, substantially as described and shown. 3. In a dynamo-electric generator or motor an iron tube, or equivalent structure, containing two interior pole pieces with field or exciting coils arranged around the said pole pieces, the coils being bent substantially as described and shown. 4. In a dynamo-electric generator or motor an iron tube, or equivalent structure, containing two interior pole pieces, and bent exciting or field coils with end plates or brackets completely enclosing one or both ends of the said tube, substantially as described and shown.

6570. "Improvements in dynamo-electric generators and motors." G. E. DORMAN. Dated April 17. 6d. A dynamo-electric generator or motor constructed according to the invention consists of a tube of cast or wrought iron, in or against the interior of said tube being four or more shallow pole pieces, attached to or integral with said tube, said pole pieces being equidistant from one another and diametrically opposite one another, and centrally within the tube and pole pieces, is situated an armature, said armature being supported by end brackets or frames, secured to the ends of the tube, which said ends said end brackets or frames may partially or entirely enclose. Around each pole piece are placed exciting coils, such coils being wound and taped, and bent or compressed in a mould or otherwise to the exact curvature of the interior of the tube; such coils are made in two or or more sections, one or more sections being larger than the other section or sections in the same coil, and between the exciting coils and armature are interposed curved plates of brass or other suitable material, which may rest on ledges on the pole pieces, when the pole pieces are detachable, or be held in place by end cylinders. 4 claims.

CORRESPONDENCE.

Faraday's Phenomena of the Liberation or Production of Ammonia from Alkalis.

Some time ago I was reading one of Faraday's papers on the phenomena of the evolution of ammonia from caustic soda, apparently not containing ammonia nor its compounds, when heated with zinc. This subject, off and on, has been engaging my thoughts for a long time, and I have been raking up a lot of old experiences in a certain series of cases where, in my dealings with alkaline batteries, there used to be a very appreciable quantity of ammonia given off in the working of the batteries, which were of a primary character. Before I go farther, I must mention that the explanation of this ammonia phenomena was hidden for a considerable time, from the fact of certain individuals, whose names, otherwise, I have cause to remember, having the audacity, or probably from necessity, to make a urinal of a certain number of tanks which were employed in dissolving the solid caustic soda; and on subsequent occasions, when the ammonia made its appearance, it was attributed to "the same old cause," which, as may be guessed, was more often a subject of amusement than of serious consideration. It transpired later, though, that both soda and potash, which had been carefully watched from the solid to the liquid condition, and to its introduction to the battery cells, still produced ammonia, although most abundantly when the circuit was closed, to the annoyance of many individuals whose olfactory nerves were not chemically educated. From this point all manner of theories were advanced in explanation, some of which exhibited the rarest ingenuity; such, for instance, as that "one of the men might have dropped a portion of his bread-and-cheese luncheon into the soda, and it was well known that caustic soda liberated ammonia from cheese;" but none of the theories were satisfactory when put to the test. I took the trouble to trace the source of the crude material from which the soda was manufactured—in one case, after the source of some potash getting over to the German deposits of potassium chloride—but still without obtaining any information which threw light upon the subject, although I felt sure it admitted of easy solution, with patience, from the fact that with pure soda or potash, arranged under similar conditions, and freshly prepared, it did not evolve ammonia.

After reading Faraday's paper I reverted back to all this, and decided, if possible, to find out the cause; and remembering that weak nitric acid, under the influence of nascent hydrogen, produces small quantities of ammonia, I began to look for nitrogen compounds in the soda.

Another subject, slightly connected at this period, began to engage part of my attention, from some suggestions made to me regarding the artificial production of nitrates directly from the nitrogen in air. To test the practicability of my friend's ideas, I devised various experimental apparatus to take up any nitric or nitrous oxides which might be contained in air, including one form to test if salt, in a moist condition, were influenced by air containing nitric oxide, as a solution of the question of the formation of nitrates in natural deposits in which the nitrate bed appears above the salt. After passing immense volumes of air known to contain traces of these acid vapours over salt, arranged to expose a large surface, I did actually, to my surprise, find a small change in the constituents of the salt, but not sufficient quantitatively to warrant me saying that the formation of natural deposits of nitrates could be explained thereby, although the result pointed to such a conclusion, especially as the conditions of atmosphere where nitrates are found encourages the change indicated, as heavy dews without absolute rain, and frequent electric discharges, to which I will afterwards refer.

I proceeded to try caustic soda for absorbing natural acid vapours contained in air, and, exclusive of carbonic acid, found the soda absorbed nitric oxide readily. I went further, and constructed an apparatus for passing electric sparks through air, with the air kept at various temperatures and under various pressures, and with caustic soda present, and found that all the mixed nitrogen oxides produced thereby were rapidly absorbed by soda or potash.

From this I supposed that the ammonia liberated in alkaline batteries was traceable to the alkali containing small quantities of nitrates, from which ammonia was produced by the nascent hydrogen set free by the zinc, and which was present by the absorption of nitric oxides contained in the atmosphere; and I found that I was correct in my supposition by subsequent actual experiment. Briefly, my experiments pointed to the fact that when ammonia is liberated from caustic soda or potash solutions, supposed to be pure, by the action of zinc, as in alkaline batteries, it is traceable to the solution containing small, may be exceeding small, quantities of nitrates as impurities, and which the nascent hydrogen, produced from the action of the zinc, enables us to detect by the formation of ammonia. The nitrates may be present as impurities in manufacture, or caused by absorption when long exposed to air, as explained. I found the nitrates in caustic soda or potash acted very well as depolarisers, and also in salt. The ammonia can be easily detected with the eye by having a little copper oxide present, when the smallest quantities of ammonia will impart a blue colour to the solution.

James C. Richardson.

The Lane-Fox Patents.

I enclose for your information a copy of a circular which this company proposes sending to the owners of private installations on the Lane-Fox system. These circulars have in the first place been sent round to all contractors, and they have been asked to co-operate with us in collecting the royalties from their own clients.

C. A. Stephenson.

June 16*th*, 1890.

LANE-FOX ELECTRICAL COMPANY, LIMITED.

66, Victoria Street, London, S.W.,
June 13*th*, 1890.

SIR,—I write to inform you that this company is prepared to grant you a license for the use of the Lane-Fox system of electrical incandescent light distribution, which has been installed on your premises.

The Lane-Fox system, which is covered by Patent 3988** of 1878, and others taken out by Mr. Lane-Fox during the years 1878 to 1883, is for multiple arc distribution of incandescent lamps; constant pressure being maintained in the conducting mains, and secondary batteries being used as reservoirs of electrical energy.

Our terms for a license for the use of the system are as follows:—

For every 16 candle-power lamp, fixed—

For private houses—1s. 6d. per lamp per annum.

For other installations, such as hotels, clubs, and offices—
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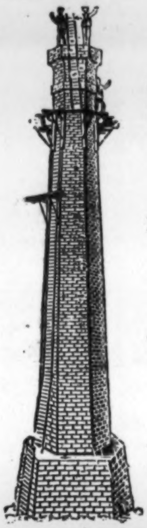

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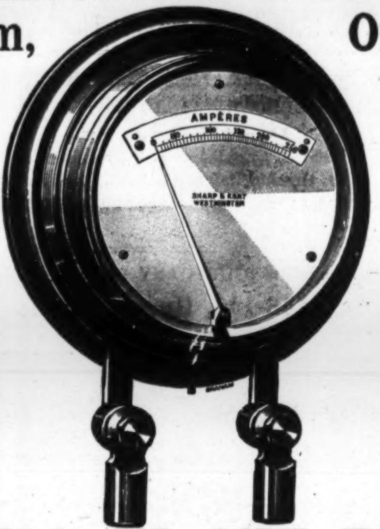

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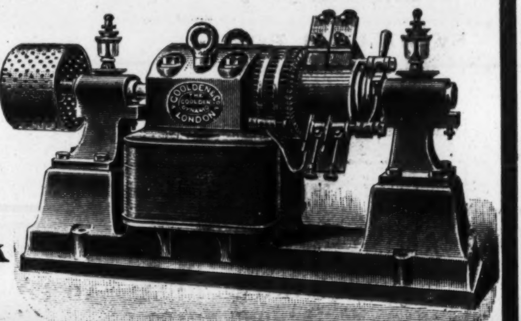

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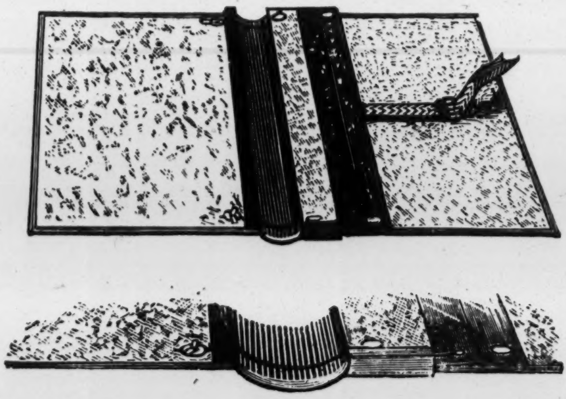

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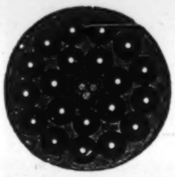

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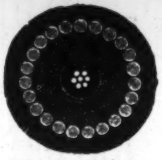

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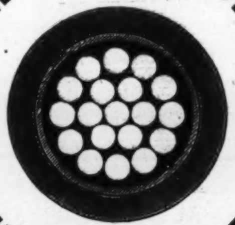

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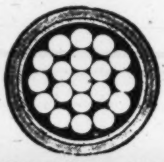

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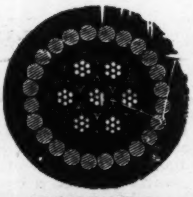

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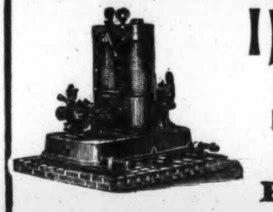

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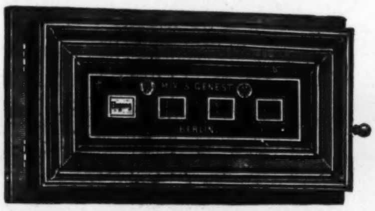

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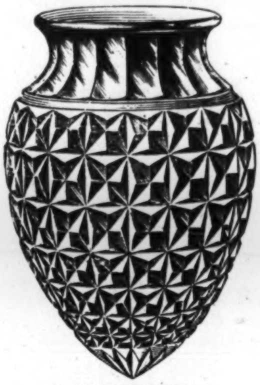
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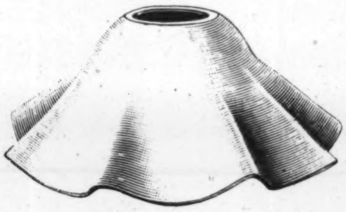
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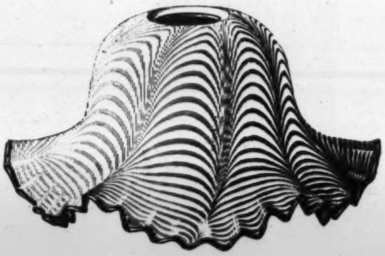
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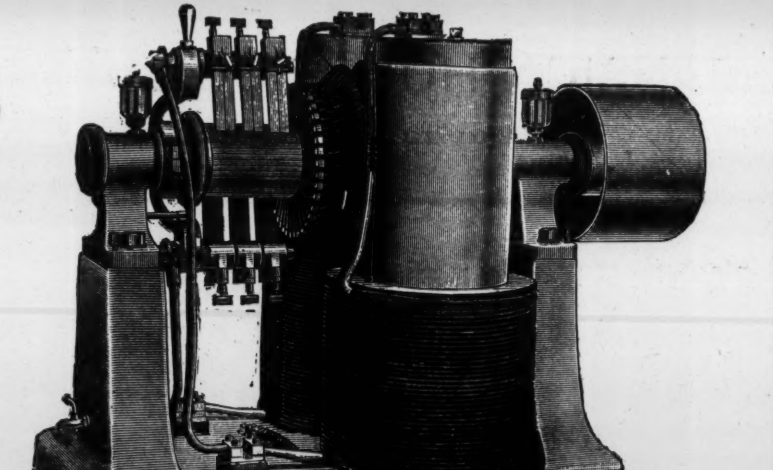

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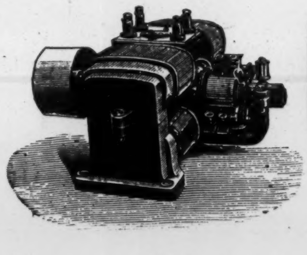

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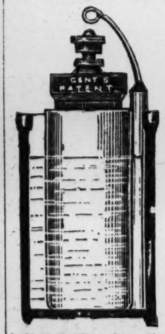

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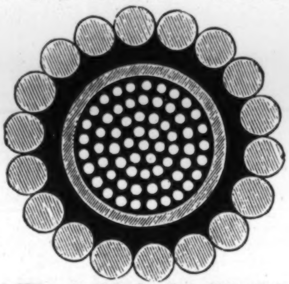

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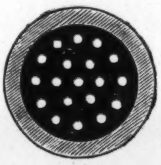
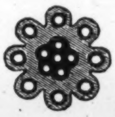
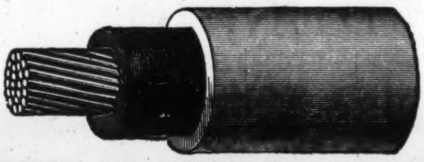
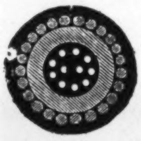
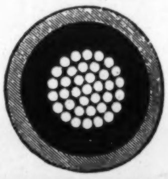

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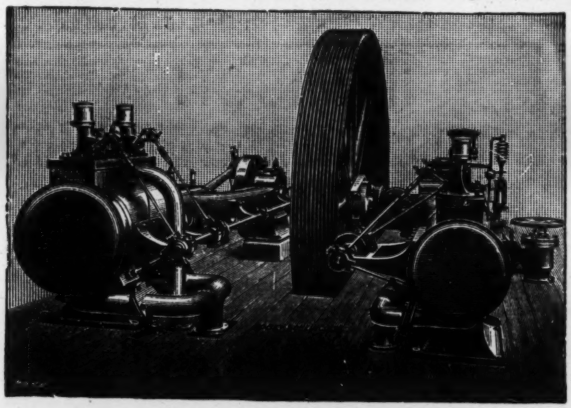

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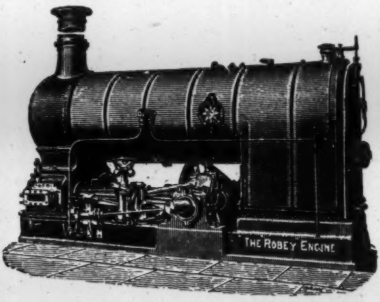

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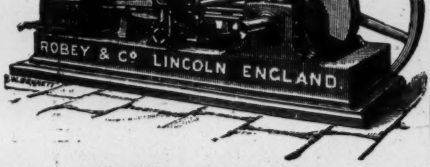
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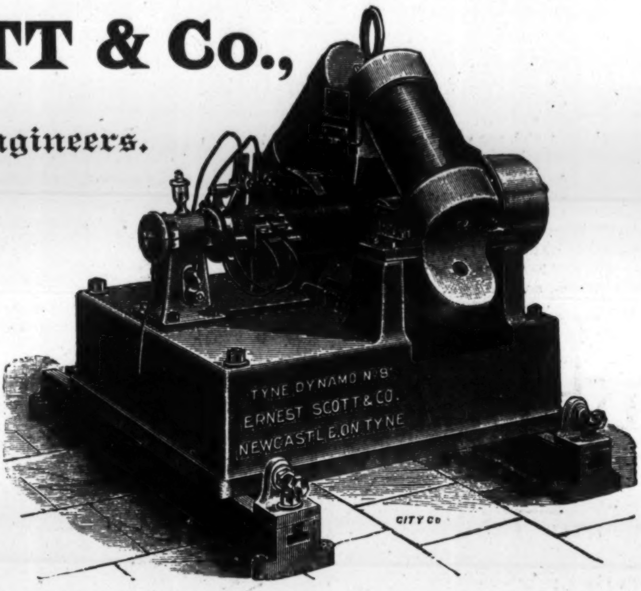

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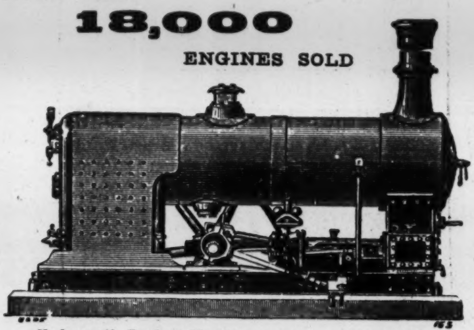

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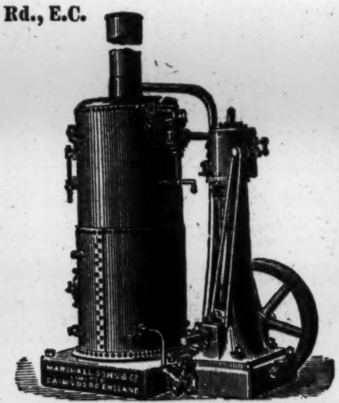

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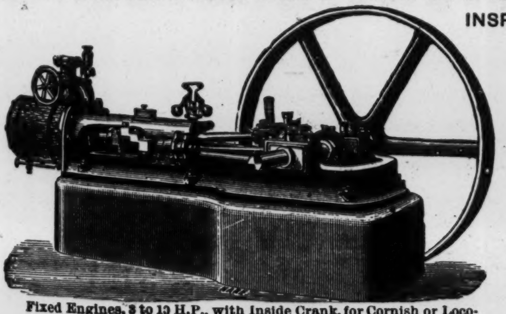

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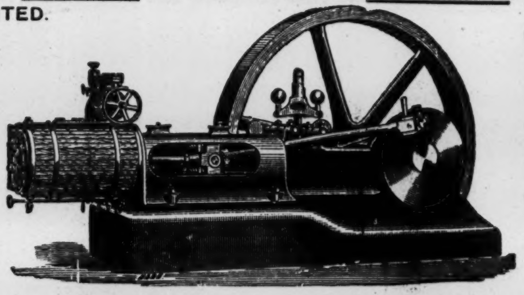

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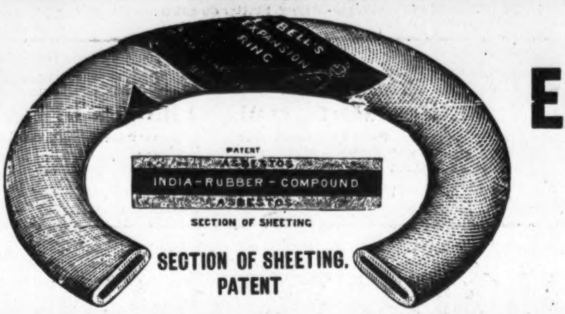

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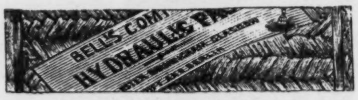

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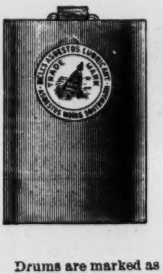
BELL'S ASBESTOS LUBRICANT.



Drums are marked as above.

Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as shown, is earnestly requested to forward us sample and particulars of where obtained.

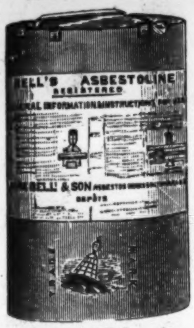
Every Cask is sent out as above.

ASBESTOS BELL'S LUBRICANT

All Corks are sealed as above.

BELL'S ASBESTOLINE.

REGISTERED.



All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A. is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C. is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

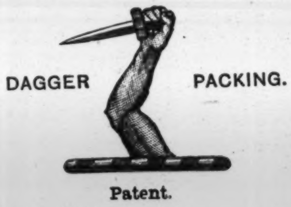
The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

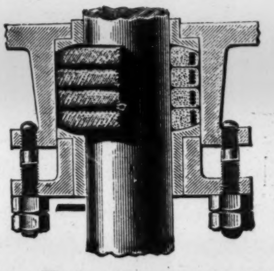
SPECIAL TERMS FOR LARGE QUANTITIES.

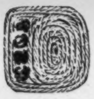
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

BELL'S ASBESTOS DAGGER PACKING

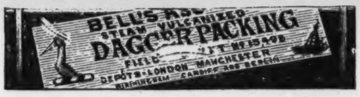


Patent.

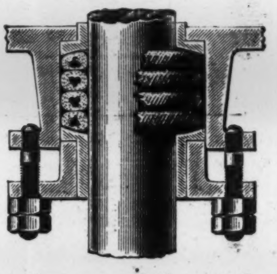




SQUARE.



ROUND.



Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

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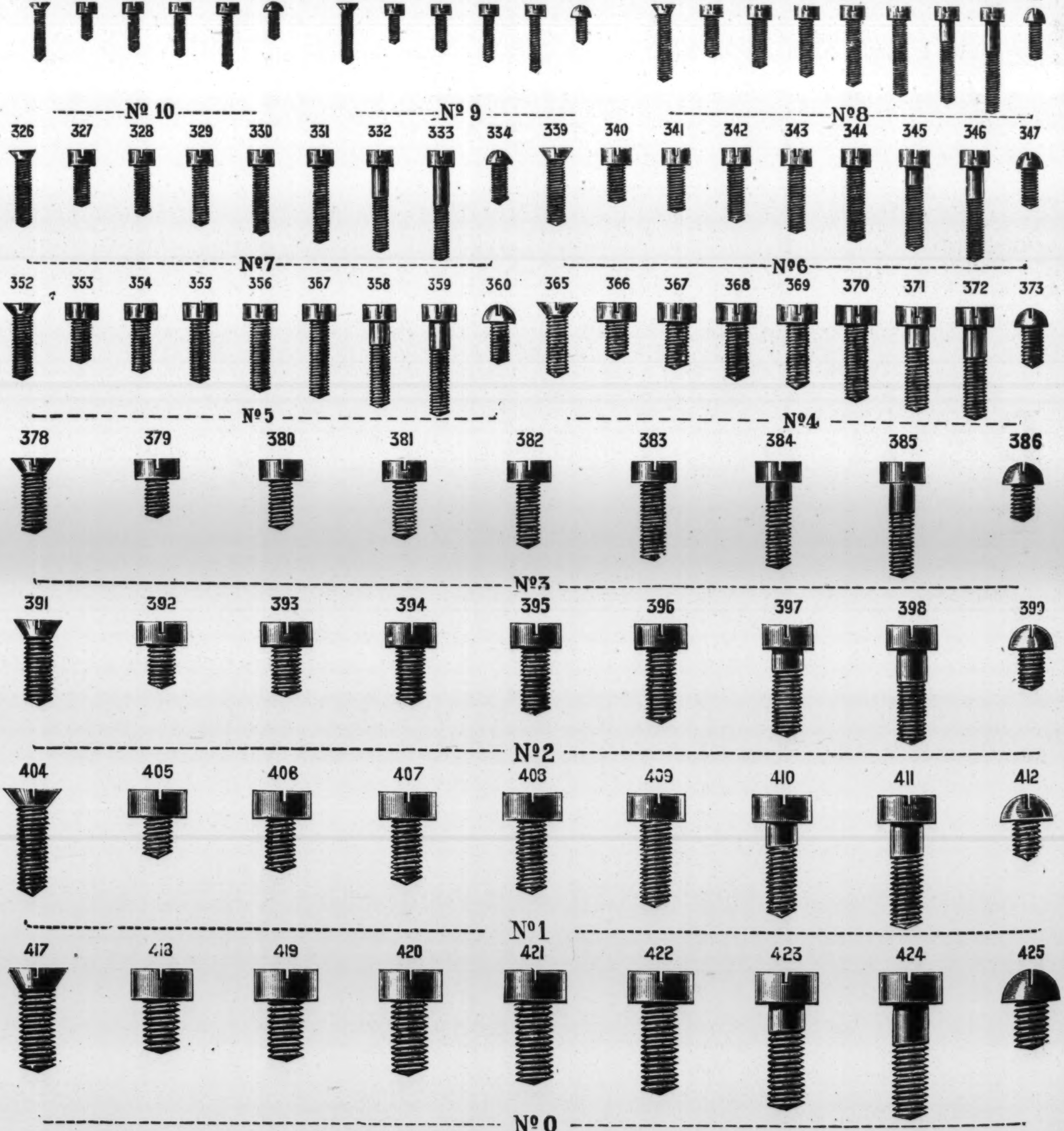

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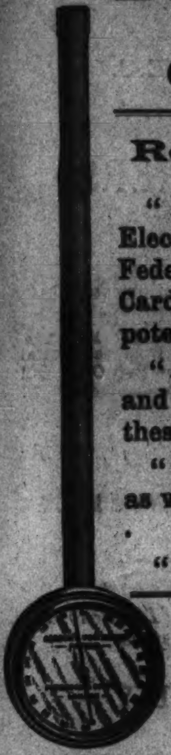
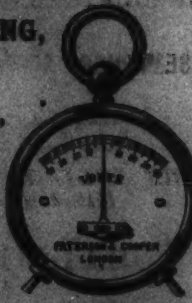


Cardew Voltmeter, [illegible]



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